Printed on thin paper for overseas circulation.

With METALLURGICAL SUPPLEMENT

The Engineer

VOL. CLXVIII.—No. 4372 28, ESSEX ST., STRAND, LONDON, W.C. 2 OCTOBER 27, 1939

Established 1856 Price One Shilling, by Inland Post 1s. 3d. Registered as a Newspaper

Engineering Library

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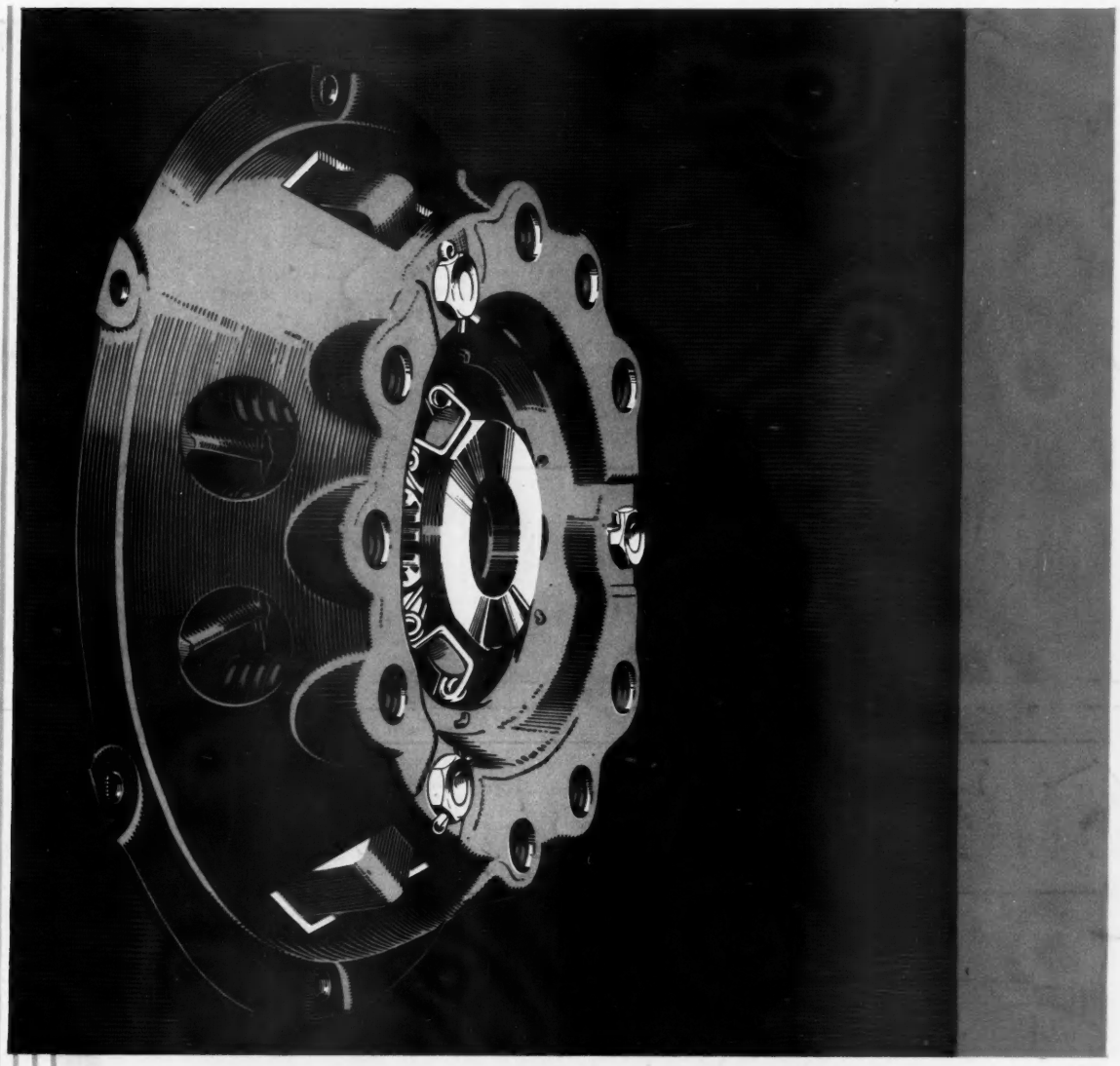

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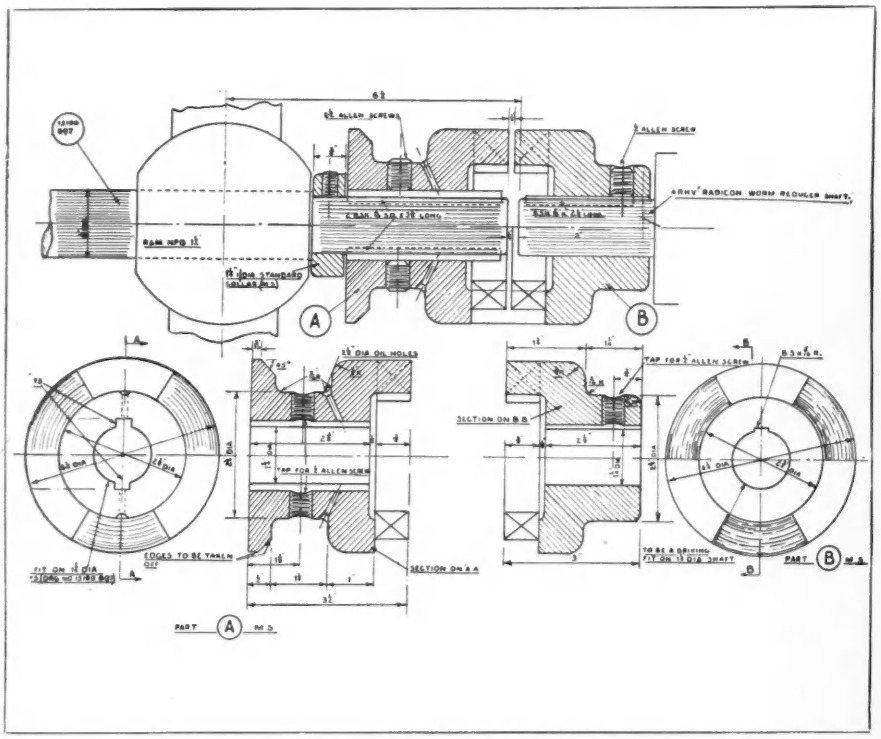

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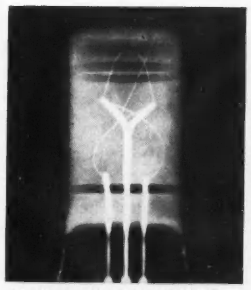

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A. R. P.

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A Seven-Day Journal

South Africa and the War

It has been said that this will be a war of minerals and metals, and South Africa calculates that she can produce enough of both not only for her own requirements, but to give a substantial export surplus to Great Britain and the Allies. Just as the war in 1914 greatly stimulated her secondary industries—textiles, leather, and the production of foodstuffs—this war should foster the development of South Africa's mineral resources. The country contains practically all the metals and ores required by modern industry, but only the more accessible deposits are now being worked. Mining products are exported in the raw or semi-processed state, while local industry relies to a large extent on imports of finished or semi-finished metals and minerals. Among the important base mineral cargoes from South Africa are asbestos, chrome, and manganese. There are large reserves of iron, copper, manganese, tin, vanadium, and chrome. The engineering industry and technical skill in the Union has since 1918 advanced very considerably and to-day can cope with most problems of plant and equipment. Two years ago Dr. Hans Pirow, then Government Mining Engineer, estimated the Union's wealth of base minerals still unwon at fully £30,000,000,000.

Railways and the War

In an article which appears in a war-time newsletter styled "Carry On" which has just been published by the L.M.S. Railway, in lieu of three staff magazines suspended on account of war, Lord Stamp points out that railways have never been more vital to the life of the nation than they are to-day. As in the other great war of twenty-five years ago, the railways are playing their part in our national defence system. It will ever be a source of pride, Lord Stamp says, to those who are connected with the railways, that when war did come it found them prepared to the last man and the last vehicle to play their part in the sudden movements of traffic required, so that these were carried through speedily and with safety and efficiency. After making reference to the railway feats performed in connection with evacuation and mobilisation, Lord Stamp goes on to say that, in his opinion, it is beyond doubt that a still greater task, sterner and more protracted, yet lies before the railways. The men of the railways have the triple responsibility of war traffic movement, of maintaining essential food and other supplies, and of enabling the civil community to carry on its work and duties. To the fulfilment of that task the railwaymen bring those qualities of courage, initiative, and resource, for which the service is famous. As their proud leader in this critical time, Lord Stamp suggests that to these qualities there should be added, too, the tradition of service which has been built up during the sixteen years over which the L.M.S. Railway Company has been in being. The financial stress of the country during war means that avoidance of waste and economical working are more important than ever and individual resourcefulness and enterprise is every man's contribution towards winning the war. It was no use merely to sit back and to say that the Government was running the railways. It was up to every L.M.S. railwayman in the face of great difficulties and swift-changing conditions to carry on with his work and to see it through to the end.

Damage by Floods and Rain

Heavy rains last week, amounting to no less than 3in. in 24 hours in some districts, caused considerable damage in the Midlands, and an area extending from Leicester down to Aylesbury, and from Coventry to Newport Pagnell, was badly affected. The railway services on the London, Midland and Scottish Railway from Euston to the North were dislocated to some extent, and on Wednesday, October 18th, trains were diverted at Bletchley, to the Bedford and Wellingborough line, because of serious flooding near Castlethorpe, where the railway track near the engine water troughs was flooded to a depth of several feet. Some of the morning traffic had to be worked from St. Pancras, and the Euston line was only re-opened after 1 p.m. In the Haversham district, the supports of a new bridge were washed away, and part of the bridge collapsed. Two other bridges which suffered damage were the Ouse bridge near Wolverton, and the wooden footbridge over the river Tove at Towcester. Towards the evening of Wednesday, October 18th, there was considerable flooding around Newport Pagnell, in which the rivers Ouse, Tove, and Ousel, and the Grand Union Canal were involved. Many roads in this area were under water. Near Bletchley, the Grand Union Canal overflowed its banks, and three miles north of Bletchley men worked unceasingly on the task of raising sluices, in order to relieve the pressure on the canal banks caused by the quickly rising water. Some seven or more hours of heavy rain caused the banks of the canal to slip at several places, but happily any danger of a serious break was averted. Flooding also occurred around Northampton and Rugby. At Rugby measures had been taken near the pumping station to prevent damage by flooding, but the pumping machinery was put out of action on Wednesday morning by floodwater. The town water supply was cut off for some hours, and one of the waterworks attendants lost his life when he was trapped by the floods owing to a fall of sandbags. On Thursday the flooding spread down the rivers, and the districts around Bedford were affected. The L.M.S. lines between Northampton and Bedford and Northampton and Wellingborough were flooded on Thursday, but they were cleared about 4.30 p.m. and normal services were resumed. The sandbag protection of buildings, both in London and the Midlands, suffered damage by the rain, and in many cases protective walls had to be reconstructed and better draining arrangements adopted. The advantage of waterproofing sandbag structures, and covering them with wood or waterproofed sheeting has been clearly demonstrated.

Chemical Research

The announcement is made that the Chemical Society has formed an Advisory Research Council, consisting of twenty of its members, under the chairmanship of its President, Sir Robert Robinson, F.R.S. The purpose for which the new body has been brought into being is, when approached, to bring to the notice of Fellows of the Society, and others who may be engaged in chemical research work, subjects for investigation which are likely to be of potential value to the nation at the present time. In the first instance, it is stated, such advice will be made available to unpaid research workers in universities, colleges, and other research institutions, and to research students in receipt of research grants not definitely related to any particular topic, or in regard to which the topic can be changed. It is hoped to effect a liaison between Government Departments and industrial organisations, so that the Advisory Research Council may know of pressing problems needing investigation and thus may be able to suggest lines of research which may be of potential value. The field which will be covered by the work of the Council will embrace every branch of pure chemistry, including biochemistry and metallurgy. A list of topics for research of national value is to be drawn up, and this list will normally be available to those wishing to make use of it. It is requested that enquiries and suggestions relating to this new chemical research scheme should be sent to the General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1.

A National Joint Council

In response to the invitation of the Minister of Labour and National Service, representatives of the British Employers' Confederation and the Trades' Union Congress General Council met on Wednesday, October 18th, at the Ministry of Labour and National Service under the Chairmanship of Sir Thomas Phillips, to consider the establishment of machinery for the joint discussion of problems which confront the Government and industry in time of war. It was agreed, subject on the part of the Trades' Union Congress to confirmation by the General Council, to set up a National Joint Council to advise on all matters in which employers and workers have a common interest, it being understood that the Council would be purely advisory and would not invade the jurisdiction of the organisation in the respective industries. It is expected that all the principal branches of industry will be represented on the Council.

Train Lighting Control

A further announcement with regard to the lighting of railway trains under black-out conditions, is made in the written reply to a question in the House of Commons, which was published by the Minister of Transport, Captain Euan Wallace, early last week. As the result of the experiments which have been made in train lighting it has been agreed that in corridor stock in long distance trains, white lighting of an intensity sufficient to afford a reasonably good reading light may be installed in the compartments. The arrangement is subject to the condition, however, that the blinds of all compartment windows must be kept drawn throughout the black-out period, and the lights extinguished on receipt of an air-raid warning by means of a master switch. The Minister announced that these new arrangements will be brought into force as soon as the necessary equipment becomes available, but, he continued, the public must be warned that the continuance of these arrangements will depend upon the co-operation of the passengers in the strict observance of certain essential precautions, particulars of which will be displayed in the carriages. The provision of reading light in the surburban trains, the Minister says, presents much greater difficulties, owing to the frequency of the stops and the use of non-corridor rolling stock. These problems are under further investigation, and meanwhile the lighting in these trains is being improved where necessary to conform to a standard which is adequate for safety on short journeys.

Ministry of Supply Appointments

On Thursday, October 19th, the Ministry of Information published particulars of the more important of the recent appointments made to the Ministry of Supply from outside the Government Service. Among the engineers the following names appear:—Mr. Gavin Smellie McLay, director of Stewarts and Lloyds, Ltd., and other firms, Honorary Adviser to the Director of Ammunition Production; Sir Frank Smith, F.R.S., late Secretary of the Department of Scientific Research, and the Royal Society 1929–1938, and Adviser on Research and Development to the Anglo-Iranian Oil Company, Director of Instrument Production; Mr. Robert S. Wipple, Chairman of the Cambridge Scientific Instrument Company, Assistant Director of Instrument Production; Mr. Percy Herbert Mills, Managing Director of W. and T. Avery, Ltd., Deputy Director of Ordnance Factories; Mr. John Watson Gibson, Managing Director of Pauling and Co., Ltd., and Chairman of Gibson and Pauling (Foreign), Ltd., Assistant Director of Ordnance Factories (Construction); Mr. Arthur A. Rowse, M. Inst. C.E., M.I. Mech. E., late Production Director, Morris Motors Ltd., and Consultant for Factory Layout, &c., Director of Machine Tools; Mr. John Rogers, F.I.C., Director of Imperial Chemical Industries, Ltd., Director of Explosives; Dr. James Wilson Armit, Secretary of Technical Committee of Imperial Chemical Industries, Ltd., Deputy-Director of Explosives; Sir Keith Price, Chairman and Joint Managing Director of Price and Pierce, Ltd., Director of Chemical Defence Warfare; Mr. Stanley Charles Robinson, F.I.C., Chairman of I.C.I. (General Chemicals), Ltd., Deputy-Director of Chemical Defence Warfare; Mr. J. Masteron, B.Sc., A.M.I.A.E., Accessory Sales Manager Joseph Lucas, Ltd., Assistant Director of Mechanisation (Spares and Repairs); Mr. R. A. Riddles, M.I. Mech. E., M.I. Loco. E., Mechanical and Electrical Engineer for Scotland L.M.S. Railway, Director of Transportation Equipment; Colonel A. S. Redman, M. Inst. T., Deputy-Director of Transportation Equipment and Liaison Officer with the War Office; Mr. J. Douglas, A.M. Inst. C.E., A.M.I. Mech. E., L.M.S. Ry., Derby, Assistant Director (Transportation Equipment), in charge of docks and outdoor machinery; Mr. A. F. Walters, A.M.I. Mech. E., and M.I.E., Great Western Railway of India, Assistant Director (Transportation Equipment) in charge of locomotives and rolling stock; Mr. H. A. Harrison, M. I. Mech. E., M.I. Loco. E., Secretary of the Institution of Locomotive Engineers, Chief Inspector; Mr. J. Maudslay, M.I. Mech. E., M.I. Loco. E., Egyptian Railways and United Steel and other companies, Officer in Charge of Allocation I. Central Priority Department. The majority of these appointments are unpaid.

Wages in the Mining Industry

At a meeting held in London on Thursday, October 19th, it was decided by the Joint Standing Consultative Committee of the coalmining industry, after carefully considering the various factors which have arisen as a result of the war affecting wage rates and earnings, to increase the wages of mine workers from the beginning of next month, by 8d. a shift for adults, and 4d. a shift for youths and boys. It is further provided that the increase shall not apply to more than six payments in any week. The increase referred to is described as a "war addition" to wages. According to the official returns of earnings for the June quarter of the present year the average cash earnings of all mine workers, men, youths, and boys, amounted to 11s. 6¼d. per shift, while allowances in kind were of the average value of nearly 5d. per shift. A national delegate conference of the Mineworker's Federation is to meet in London on Friday, October 27th, to endorse the agreed terms which were agreed upon by the Joint Standing Consultative Committee, on which both the coal owners and the unions are represented. A delegate conference of the South Wales Miners' Federation which met on Saturday, October 21st, recommended the acceptance of the offer to its lodges. The views of the lodges are to be ascertained and will be reported to a conference of the Miners' Federation of Great Britain, which is to take place in London on Friday. In Yorkshire it is understood that the representatives of some of the miners will oppose the award on the ground that it is not adequate.

Scottish Locomotive Experiences

By E. H. LIVESAY

No. VI.—L.N.E.R. GLASGOW–EDINBURGH TRAINS. "PACIFIC" CLASS ENGINES

(*Continued from page 392, Oct. 20th*)

IN the preceding article of this series it was mentioned that there are very few railway routes in Scotland with easy gradients, the existing few being found in the southern area. The L.N.E.R. line between Glasgow and Edinburgh is certainly one of them, as upon it, with the exception of the two extremities, gradients worth consideration come into the same category as snakes in Ireland. On leaving Queen Street Station, Glasgow, there is the severe 1·5 miles incline to Cowlairs station of 1 in 42, and at the other end there are a few yards of 1 in 300 and 1 in 500 outside Waverley Station, Edinburgh. Right in the middle, at Polmont, there is ¼ mile of 1 in 600; apart from these, there is nothing elsewhere steeper than 1 in 809, so it will be agreed that no great calls are likely to be made on locomotive power, and nothing spectacular in performance need be looked for. Train loads, too, are not very heavy, as the service is so frequent; "little and often" is the aim, and the L.M.S.R. takes its share of the traffic. The fastest time by the L.N.E.R. route is 58 minutes, an average speed of 50 m.p.h., though actually some of the stopping trains do the most meritorious performances, as, in spite of the stops, they are not allowed much more time.

In this article I am describing three runs with "Pacifics," which are fairly typical of the work done over this short route. The "A4" class, 4–6–2 type, was described at some length in "The Flying Scotsman" article (THE ENGINEER, March 31st), so little more need be said about it here, but as the "A1" class comes into this account, it may be of interest to deal with the genesis of the "Pacifics," to show how they came about, and how the latest "A4" design developed from the earlier prototype. The basic measurements remain unchanged, such as wheel-base and diameter, boiler dimensions, etc.; the arrangement of the cylinders and valve-gear is the same. But many detail alterations have been made since the design was first brought out, resulting in greater power, economy, and speed, and these "Pacific" class engines provide a good illustration of how an originally sound locomotive conception can be expanded to keep pace with the increasing demands made upon it by heavier traffic requirements, without any drastic alterations being necessary.

During the first two decades of the century, the heaviest express work on the Great Northern section of what is now the L.N.E.R. was done by the Ivatt "Atlantic" 4–4–2 class engines, with 2 cylinders, a large boiler, and wide "Wootton" firebox. But time marched on; these exceedingly willing engines became overpowered, six-coupled wheels were called for, and the "A1" class of "Pacifics" was brought out in 1922. It is easy to see many of the old "Atlantic" characteristics reproduced in these engines; a larger boiler was provided, with the same type of firebox; three 20in. cylinders took the place of two, and Walschaerts valve-gear was substituted for the Stephenson pattern. The boiler-pressure became 180 lb., and the superheater, giving a surface of 525 sq. ft., was housed in 32 flue tubes.

The "A1's" were the first "Pacific" class express engines in Great Britain, leaving out of consideration a solitary example, "The Great Bear," on the G.W.R., an experimental machine, never repeated, and since converted into a 4–6–0. Some very fine "Pacific" express tank engines ran on the erstwhile Brighton line, but the foregoing paragraph refers to tender engines.

It may be worth drawing attention to how little "tractive force" means in estimating an engine's real capabilities. The "A1's" had a tractive power at 85 per cent. b.p. of 29,835 lb.; the L.M.S. 4–6–0 "Royal Scot's" figures are 33,150 lb., yet there can be no question as to the much greater capacity of the Pacifics for sustained hard work and haulage. The boiler-power of the "A1's" is far greater than that of the "Royal Scots," and it is in the boiler and firebox that an engine's real potentialities lie.

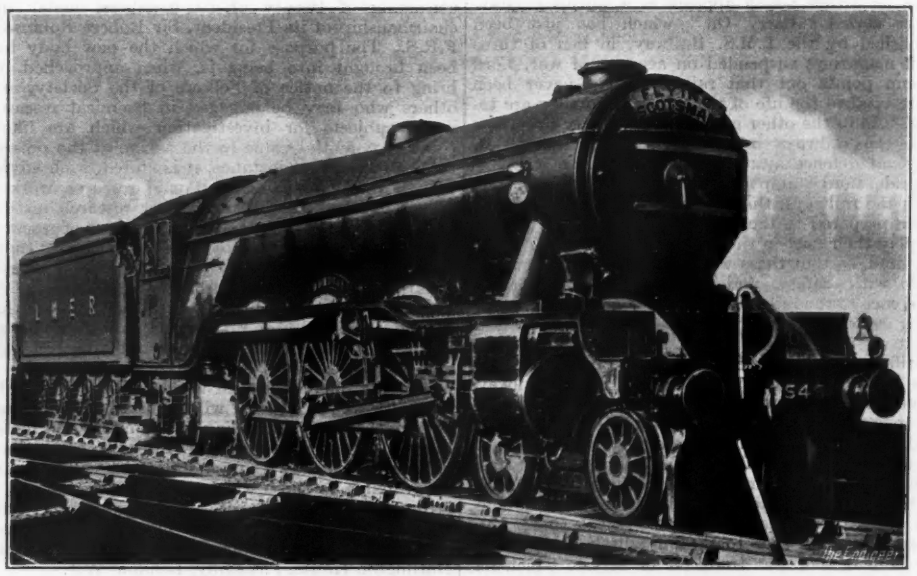
The "A2" class consisted of five "Pacifics" of the late Sir Vincent Raven's design. They were not a great success, and were cut up a few years ago. They were quite different to the Gresley "Pacifics," the three cylinders all driving the first coupled axle.

In 1925, as a result of claims made by proponents of such things as high-pressure and long valve-travel, exemplified by the G.W.R. "Castle" class of 4–6–0's, it was decided to test the conflicting theories in direct competition, and an exchange of engines was arranged by the General Managers of the two Companies, an L.N.E.R. "Pacific" taking duty on the Paddington—Plymouth route, and a G.W.R. 4–6–0 between King's Cross and Doncaster. The tests lasted a week, after a week of preliminary running had been done to accustom the drivers to their respective strange routes.

It may be said that the results summed up largely in favour of the G.W.R. long valve-travel and high-pressure practice. Neither engine had any difficulty in doing the work normally carried out by the other, though the G.W.R. 4–6–0 was considerably smaller in firebox and boiler, and of less weight than the "Pacific," and burnt less fuel. This was to be expected, the only remarkable thing being that the result should have caused any surprise. The outcome was that the valve-travel of the "Pacifics" was lengthened, and a new class, the "A3," brought out in 1928, with the steam-pressure raised to 220 lb., a larger superheater, and the cylinders reduced in diameter from 20in. to 19in. Many of the "A1" class were subsequently rebuilt with the same improvements. In passing, it may be mentioned that G.W. engines still work with the low-superheat referred to in the last article. Were this to be raised these fine engines would probably do even better work, with lower fuel consumption. Incidentally, my sympathetic soul probably would not have been disquieted as it was on the footplate of "King William III" during the "Cornish Riviera" run, owing to watching the fireman's strenuous work—the cankerworm of care would not have so gnawed at the vitals of either of us on that occasion.

In 1935, the L.N.E.R. "Pacifics" were developed still further, by raising the steam-pressure to 250 lb., and the adoption of a combustion-chamber, which increased the firebox heating-surface; this shortened the tube-length by one foot. The cylinder diameter was decreased to 18½in., which left the tractive-power practically unaffected, as the increased pressure offset the reduction. Considerable improvements were made to the front-end, bringing about easier steam-flow into, and out of, the cylinders. The "A4's" have automatic "jumper" blast pipe tops, similar to the G.W.R. arrangement; this device was first adopted by Churchward on that line. Some "P2" class engines have double blast pipes and chimneys. Streamlining was adopted, the horizontal wedge-system being settled upon, after experiments had been carried out with several plans, having the additional end in view of raising the exhaust steam well above the cab. Difficulty still exists with this, to a certain extent, all the more in evidence when the double blast pipe arrangement is fitted. This same trouble is found with most modern engines, owing to short cut-off operation, and it is hard to say what can be done about it.

This is a brief outline of the inception and development of the "Pacific" class on the L.N.E.R., which has done such admirable work over a period of many years, and has made locomotive history in more ways than one. It is difficult to see how the class could be still further developed, axle-load limitations probably making it impossible. Except perhaps in one direction—by increasing firebox dimensions, which has already been done experimentally in the case of No. 10000, really a "Pacific" enlarged into a "Hudson" 4–6–4, built on the left-over chassis of the defunct high-pressure water-tube boiler engine. The grate area is 50 square feet. It is an interesting expansion, in the only direction that expansion could very well take place; the firebox is the heart and soul of a locomotive, and any increase in capacity there is to the good of the whole engine and is sure to have considerable effect. The reports are that No. 10000 is doing fine work, showing a greater haulage endowment than the standard "A4's," which goes to show the benefit even a slight increase in firebox dimensions can give, though granted, it is coupled in this case with an enlargement of the cylinder diameter to 20in. For ease of comparison, some of the chief dimensions of the three "Pacific" classes are given in the following table:—



L.N.E.R. A1 CLASS LOCOMOTIVE

Dimensions of L.N.E.R. "Pacific" Class Engines

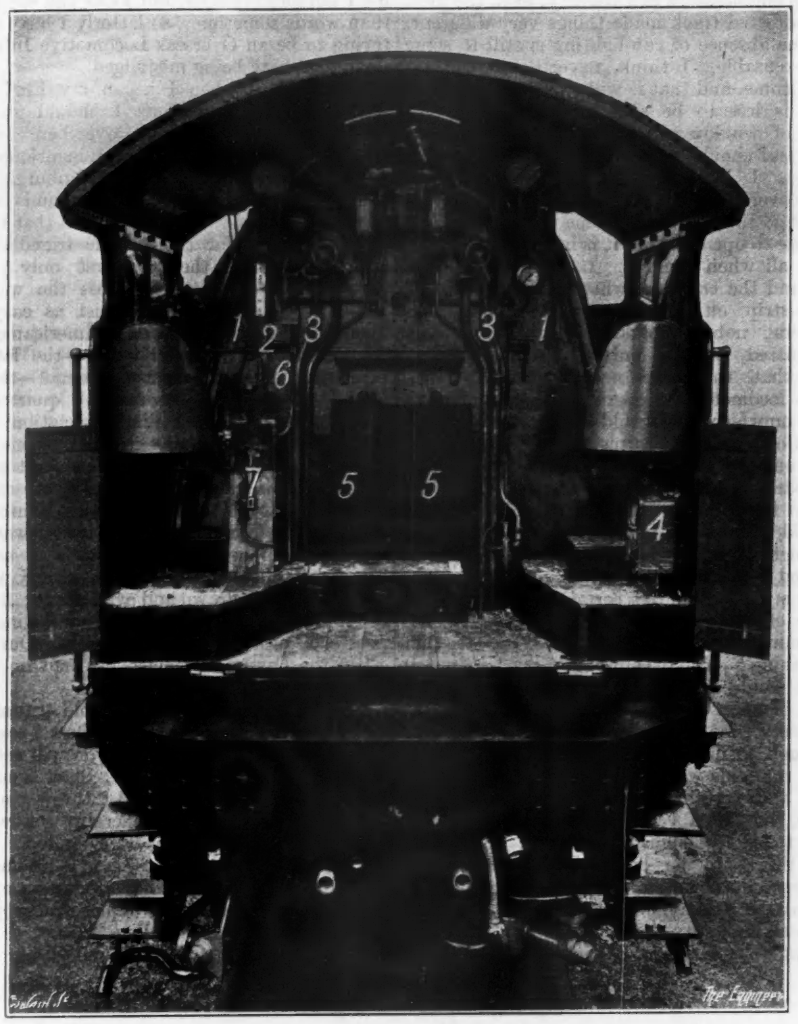
	Cylinders.	Heating surface. sq. ft.	Steam pressure. lb.	Tractive effort. lb.	Weight (engine). tons cwt.	Weight (tender) tons cwt.
A1.	20in.	3455	180	29,835	92 9	56 6
A3.	19in.	3398	220	32,909	96 5	57 18
A4.	18½in.	3325	250	35,455	102 19	64 3

The first run to be reviewed was on "A1," No. 2564, "Knight of the Thistle," with the 8.35 a.m. train out of Queen Street Station, Glasgow, for Edinburgh—ultimately Doncaster and Harwich. The load was 310 tons gross, very moderate for a "Pacific," and the crew were Messrs. McCarrom and McDeguaid. Starting promptly to time, assisted by a banking engine at the rear, as is always the case up the Cowlairs incline of 1 in 42, the regulator was half open, the cut-off, at first 55 per cent., being shortened to 40 per cent. at the top of the incline, and progressively reduced to 35–25 per cent. on the level stretch to Bishopbriggs. Lenzie, 6¼ miles, was passed at 8.48 a.m., 13 minutes from the start; steaming was evidently good, as blowing-off took place twice in the first few miles; the working pressure with the "A1's" is 180 lb. After Lenzie, the c.o. was still further shortened to 17 per cent., with half regulator. The riding was satisfactory, the tender

behaving even better than the engine, making note-taking a simple matter. Clearly there was nothing the matter with the draw-gear on this engine. But when I marked down No. 2564's action as "good," I had not then made the acquaintance of "V2," No. 4793, or I might not have been so complimentary. Since that epochal trip, locomotive-action has always been to me, like Truth, absolutely relative.

There was a slowing to 10 m.p.h. for a permanent-way restriction passing Waterside Junction, and when speeding up again afterwards, the regulator was $\frac{3}{8}$rds open, and the c.o. 25 per cent. At Croy, 11·5 miles in 23 minutes, a similar speed-reduction took place; also at Dullatur, 1·5 miles on; and yet again, at Castlecary, passed 9.03 a.m., 28 minutes for the 15·5 miles from Glasgow. These successive slowings, all down to 20 m.p.h. or less, must have been partly due to signals—something was evidently just ahead of us—and they made it impossible for No. 2564 really to get going; the speed so far had been very unobtrusive. After Haymarket stop was made at 9.40 a.m., two minutes late, the 46 miles having been covered in 65 minutes, 42·5 m.p.h., with one intermediate stop, and several severe checks. Waverley Station, Edinburgh, was finally reached at 9.43 a.m., one minute late. It had been an interesting run, over fresh ground, but there had been nothing out-of-the-ordinary about it, as the timing was easy, and the load moderate.

The next run is chronologically out of order, but I give it here, so comparisons may be made with the one just described. It was over the same route, in the same direction, and with a very similar load. The engine, however, was an "A4," No. 4487, "Empire of India," similar to "Dominion of Canada" and the train was the 11 a.m. to Edinburgh. I was very glad to find that the driver was Dan Maguire, with whom I had made the northern half of the "Flying Scotsman" journey, described in THE ENGINEER of March 31st. His right-hand man—literally, as the engine was a left-hand drive one—was Fireman



CAB OF L.N.E.R. A4 CLASS EXPRESS LOCOMOTIVE

Bonnybridge, succeeded by a p.w.s. to 25 m.p.h., whatever had been in our way was disposed of, and the landscape began to move by a little faster. Falkirk was passed at over 70 m.p.h., at which speed I marked the running as "steady." But this burst of speed was short-lived; it had to be cut for the Polmont stop, made at 9.15 a.m.; 25 miles in 40 minutes, with the Cowlairs incline and five slowings inclusive. Polmont was left at 9.16 a.m., three minutes late, speed rising rapidly on 22 per cent. c.o. and half regulator; Manuel, 2·5 miles, was passed at 60 m.p.h., and Linlithgow, 9.22 a.m., at 70. This engine, like other older L.N.E.R. designs, had right-hand drive, which is not at all convenient for sighting signals on left curvature. Under such conditions, the fireman—who, of course, knew from experience just where these awkward points came—was always ready for the first sight of the coy signals, and to pass the word to the driver.

The great half-mile curved viaduct at Ratho brought the speed down to 30 m.p.h., after which it rose again, and Gogar was run through at over 70 m.p.h. I should mention that these speed-figures are all approximate, as there was no indicator on this engine. If anything, they are probably under, rather than over, the mark. The Beatty, so it is hardly necessary to say that he is generally known as Admiral. The omens were all propitious, pointing to a faster run. An "A4," with Maguire and "Admiral" Beatty in charge; a beautiful spring day, and tighter timing than on the previous "A1" trip; what could be more promising?

The start was made from Queen Street Station punctually at 11 a.m., and we were away into the tunnel on 65 per cent. c.o., and up the simultaneous 1 in 42 incline, with fine acceleration that took us through Cowlairs in $4\frac{1}{2}$ minutes. Once on the level, the c.o. became 28 per cent.; Bishopbriggs was passed at 65 m.p.h., and Lenzie at 70, 9·5 minutes for the $6\frac{1}{4}$ miles from the start. This shows how much faster the "A4," No. 4487, had got away than the "A1," No. 2564; the latter took 13 minutes over the same stretch to Lenzie. The p.w.s. at Waterside Junction brought the speed down to 10 m.p.h., but before Croy, 11·5 miles, was passed at 11.15$\frac{1}{2}$ a.m., it was again 70 m.p.h., and rising. Passing Castlecary, 15·5 miles in 19 minutes, it was 75 m.p.h., but brakes went on through Bonnybridge for a p.w.s. to 25 just beyond. Accelerating again with c.o. 35 per cent., it came back to the usual 17 per cent. running position before steam was shut off for the Falkirk stop, made at 11.27 a.m., three minutes ahead of time; 21·5 miles in 27 minutes, speed 48 m.p.h. No. 2564 had taken 36 minutes to pass Falkirk non-stop. "Empire of India's" running was altogether snappier, acceleration was quicker, and maximum speed higher.

Falkirk was left on time, at 11.32 a.m., and we passed Polmont, 3 miles on, at 70 m.p.h. This engine, I should explain, had a Flaman recorder in its usual position, under the fireman's seat, and speed figures are taken from it. At Manuel, 27 miles, 11.38 a.m., it had risen to 80 m.p.h., and again at Philpstoun, on a slightly rising gradient, it touched the same figure, after which we were checked by signal, down to 35 m.p.h., nearing Ratho. Once over the viaduct, with its 30 m.p.h. restriction, No. 4478 accelerated faster than I have ever experienced before on any engine, until before Gogar, the Flaman was again indicating 80 m.p.h. I was in the "Admiral's" seat at the moment, with my nose in the gradient-book, when my attention was attracted by a hail from across the cab. Maguire was making pantomimic signals, the meaning of which I finally grasped—he wanted me to bend down and look at the Flaman under the fireman's seat. Assuming the graceful arc one has to take up when looking at it, if you remain seated (see engraving of cab)—you practically stand on your head—I saw the hand was quivering on the 80 m.p.h. mark, and guessed that Maguire thought this would please me. It did, but having had my leg gently pulled by enginemen on other occasions, I thought this would give me the chance to get a little of my own back, so I pretended that 80 m.p.h. was a mere crawl, and that I expected something altogether better from No. 4478 and her top-link crew. My adjuration to "step on it!" only brought a laughing negative, as of course I knew it would. Maguire was far too experienced a man to indulge in any unwarranted speeding for no adequate reason, or to let anything override his judgment. Running a locomotive is a serious job; 80 m.p.h. was fast enough, and in any case, we were already ahead of time, and had been so at every point clean back to Glasgow, so that figure remained the maximum, and shortly after, we were slowing through Haymarket, preparatory to coming to a stand in Waverley Station at 11.57 a.m., five minutes ahead of time. The 47 miles had been covered in 57 minutes, an average of nearly 50 m.p.h., inclusive of one five minutes stop at Falkirk, and three checks to 10, 25, and 30 m.p.h. respectively. The outstanding feature of the trip was the Falkirk—Edinburgh section, the 25·5 miles having been covered start-to-stop in 25 minutes, an average speed of 61 m.p.h. This is the fastest I noted on any of the runs between Edinburgh and Glasgow; as a matter of fact, it was not exceeded during any of my Scottish experiences. Maguire had certainly made the run as sprightly as possible, and he could have done no better, except by shooting the working time-table to pieces, which he would have been the last person to do. Of course, the run had been really quite easy; there are no gradients worth mentioning between Glasgow and Edinburgh, apart from the Cowlairs bank; the timing had been nothing out of the way, and the load light.

The next run can only be dealt with in a cursory manner, as it began at dusk, and ended in darkness, which complicated detailed note-taking so much that I practically gave up the struggle a few miles out of Edinburgh, just as I had been forced to do at Carlisle on the "Mid-day Scot," contenting myself with absorbing general impressions. The engine was an "A1," No. 2581, "Neil Gow," on the "Queen of Scots" Pullman Limited, which leaves Edinburgh at 7.10 p.m. The load was 375 tons gross; my inability to take notes seems to have extended to the names of the crew also, because I cannot find them. This engine was also of the right-hand drive type, and I again noticed how awkward it sometimes made signal observation from the driver's side. Curvature on this route is not very severe, yet there were several places where the fireman had to be ready to pick up signals, and to pass on their message to his mate. Needless to say, he was never caught napping.

The absence of window-wipers—I have mentioned this several times, and will do so again here. I had carefully cleaned the fireman's window before the train pulled out of Waverley, but the Haymarket Tunnel at once gleefully put paid to my optimistic work. On coming out into the open, I found that the vigorous exhaust had brought down quantities of soot from the roof, and it was stuck in a paste-like consistency all over my cherished glass. It was just as if a little boy had been making soot-pies, and had flung his products

at the windows, both of which became at once neither ornamental nor useful. Fortunately, most L.N.E.R. engines have those invaluable deflector-strips at the cab-side, which can be cleaned when running, and looking ahead through them is a pleasure; they took the place of the blacked-out windows.

The "Queen of Scots" is a fairly fast train, making the 47-mile trip in 63 minutes, with one stop at Falkirk, so there was no dawdling en route. 80 m.p.h. was reached between Philpstoun and Linlithgow, and 65–70 seemed a favourite figure. The riding was pretty rough, a good deal of the rear-end sway and jerkiness that I have noticed at times on "Pacifics" being evident, but in this case it may have been due to the fact that the engine had done nearly a year's running since its last shopping.

The Falkirk stop was made at 7.39 p.m., the 25·5 miles having been covered in 29 minutes, an average speed of 52·7 m.p.h. Getting away again at 7.41 p.m., speed was soon again high, 75–80 m.p.h. being reached on the gentle decline between Bonnybridge and Castlecary. It was quite dark by now, so I could take no notes of anything inside or outside the cab. There was a restriction to 10 m.p.h. at Waterside Junction, after which nothing occurred to hinder our progress, and the usual cautious descent of the Cowlairs incline brought the train to a stand in Queen Street Station on time, at 8.13 p.m. The 21·5 miles from Falkirk had taken 32 minutes, average 40·3 m.p.h. Nothing very striking, but nevertheless a good run. To the observer in the cab, it seemed faster than it really was, the darkness lending enchantment to the roughness of the motion, I suppose, and exaggerating my impressions.

This seems a good opportunity to say once more something about cabs and cab-fittings. Several times in these articles I have referred to the good impression made upon me by the foot-plate arrangements and controls of modern L.N.E.R. engines. They are without doubt the best I have seen in England, and are fully equal to any of which I have had experience in Canada or America. No doubt I am critical during these footplate journeys, but after all, criticism is partly their *raison d'etre*, and I am sure my fastidious eye is far more wishful to be appreciative than deprecatory; in L.N.E.R. cabs it has small reason to be the latter. The illustration on page 415 shows clearly the features I have mentioned before; the double-lever regulator (1) worked equally easily from either side of the cab; the cut-off scale (2) placed vertically on the firebox, in full view; the combined water-gauge controls (3) simultaneously cutting off both entries to the boiler in the event of a glass-breakage; the wide spacing of the different handles and wheels, making them easy to manipulate. Minor details show that the same thought has been given to them; the screening doors (5), preventing straying heat and light-rays, and even the shape and position of the "cut-away" cab-side, all make it evident that the enginemen's comfort and convenience have been taken into consideration, in small things as in great. For instance, if the reader will look at the engravings, he will notice that the "cut-away" by the cab door is unusually high up. There is a very definite reason for even that little individuality, which the uninformed might think immaterial, or overlook altogether. A driver told me that, as the cab was originally shaped, the men noticed that wind swirled in round the then larger and lower cut-away, catching them in the back, occasional lumbago resulting! So the cut-away was raised, keeping rude Boreas away from sensitive parts of the engine-men's anatomy. How well seat-back and cut-away synchronise is shown in the picture of the cab. I am sure some of the older school of designers would manifest no such consideration and common-sense as this; no alterations would be made in anything, even if the men complained they were blown clean out of the cab. They would probably just be carpeted for leaving their engines when on duty! I would like also to draw attention to the bucket-seats, which are comfortably padded; to the invaluable glass deflector-strip at the cab-side (out of sight in the engraving), and to the Flaman Recorder (4) under the fireman's seat. The horizontal reversing-handle (6), too, just to the right of the driver's seat, is far more convenient than the usual vertical wheel or handle in front of him; (7) is the reversing gear vacuum clutch-lock handle. Altogether, the cab is as well arranged as it can be, the absence of window-wipers being the only thing I can cavil at. Finally, the cab-roof is connected to the front of the tender by rubber-sheeting, preventing all objectionable draughts, and three slides in the roof ensure adequate ventilation, and reasonable coolness in hot weather.

Comparing English and American cabs, our loading-gauge limitations, and national habits of railway-working and thought, should always be borne in mind, not forgetting the effect of the climatic moderation with which we are blessed. I say "blessed" advisedly, when one thinks of what Canadians have to put up with, and pretend to like. Cab-lighting, for instance; I am all in favour of it, but American conditions brought it about across the water earlier than was to be expected here. Over there, from the beginning, headlights were essential, which was not the case in England, and electricity was sure to be used sooner or later to make plain the path in front of the locomotive. It then became a natural and obvious thing to use some of the available current for cab-lighting, and in other places about the engine. Had electricity not been, so to speak, on tap, one cannot be certain that perfect footplate illumination would even yet be found on modern American engines. In this country, from the first, a well-protected track made things very different, and so the absence of cab-lighting is still to some extent excusable. I think, nevertheless, that it ought to come, and that it will.

There is less to be said in palliation of the absence of window-wipers. They are definitely needed, and should have been a standard fitting long ago. I have frequently found windows useless, covered with oil, water, and soot, with no means of getting rid of it; some windows are not even made to open, so that it is impossible to clean them at all when running. Looking out is then done round the cab-side, where there is often no deflector-strip either. The cheapest motor-car has wipers; nobody would dream of buying one not so fitted, because universal experience has proved that they are necessary. Why then should a locomotive be operated without them, a machine on which they would be equally valuable?

It has often seemed to me that if, in the past, some locomotive engineers had driven or fired their own productions, they would soon have seen the necessity for altering many things. Enginemen have said this to me more than once, and they surely ought to know what they are talking about. I laughed once with one keen young fireman; drawing my attention to a certain fitting, a glaring example of complete indifference to convenience and common-sense, he said: "Look at that flamin' thing! You'd think they tried to put it where it would be most awkward to get at, and they've bloomin' well succeeded. It makes me cough every time I have to work it. A fireman's got enough to do without playin' cat's-cradle!" I admit that this was not on a strictly up-to-date engine, and certainly it was not a L.N.E.R. machine, but to a certain extent, this diatribe applies to many engines on which one would expect things to be better. Cab-comfort and convenience do not seem to me trifling matters—they may be synonymous with safety, and certainly with humanity.

Talking to a Glasgow official one day, he enquired: "How do you get along with the enginemen?" I assured him that I never had any difficulty; that I liked being with them, and that I had never noticed any objection on their side. "Well, it does not always work out like that," he said; "I have known cases where a driver has ordered an observer off the footplate." I said I could easily believe it—I would order some people to go farther than that if I were a driver, and would give them a hefty start in the direction of their appropriate spiritual home, too. Interfering busybodies, claiming knowledge they do not possess, who criticise, and—worse still—tell a driver how to handle his engine; those are the kind of people I refer to. Personally, I go on a footplate to gain information, not to impart it, even if I have it to impart, which is seldom the case. It has always been willingly given to me. I admit getting into trouble occasionally through telling enginemen about things American, such as 550-ton Mallet freight-engines, 200-ton tenders, and a 14,000-ton load hauled experimentally single-headed. They are far too polite to come out flat-footed and tell me I am an untruther, but looks can speak louder than words sometimes, so latterly I have given up trying to be an Overseas Locomotive Information Agent. I hate being misjudged.

I remember, when I began my English runs, wondering what relations I should succeed in establishing with enginemen over here; in fact, I was somewhat concerned, as I mentioned in the account of the first journey to Edinburgh with the "Flying Scotsman." I soon found that my apprehensions were groundless, and that there was no justification for them. The friendliness that I met with from the very first only paralleled what I had experienced across the water, and Scottish enginemen proved just as easy to get along with as their English and American confreres. Instance, Maguire and Kinnear—the latter now promoted, and no longer a fireman—the Gaelic half of the "Flying Scotsman" quartet. They had not forgotten our first association, and the warm hospitality they extended to me when I came north again has left very pleasant memories. Maguire behind the wheel of his "wee car," from which he showed me the beauties of Edinburgh and the Firth of Forth, is as well worth watching in that position as at the regulator of an "A4." The re-establishment of contact with Kinnear was at first more air-drawn and evanescent; it took the shape of a wave and a laugh as our engines flashed past each other at 60 m.p.h. on the Dundee line. Even the Castlecary smash has had no effect on Kinnear's nerve or good-humour.

It all just goes to prove the old truism, applicable to most human relations—show a real interest in a man and his work, and you will get a correspondingly pleasant response. Show a superiority (probably non-existent), and "throw your weight about," and you will generally get what you deserve—the boot. This is even more likely to occur in the confined quarters of a locomotive cab than in other places. I have found by experience that there are many more unpleasant people in the world than enginemen. *Verb. sap.*

(To be continued)

Harbours of South Africa

SINCE the year 1910, when the Transvaal, Natal, Orange Free State, and Cape Colonies were brought under one Government as the Union of South Africa, the volume of imports and exports has steadily increased, and from 1925 with growing rapidity, necessitating the carrying out of extensions to the harbours' accommodation from time to time. To-day huge development schemes for the four principal harbours of the Union are being carried out, which, it is believed, will be completed by 1942, although it is doubtful whether, even then, the accommodation will be adequate to meet the growing demands. Additional ships are being put into service every month and more and more big liners are entering the trade. Prior to the war these increases were only in regard to the normal trade expansion, but as a result of the international position and the fears of trouble which might involve the safety of ships using the Mediterranean, it is known that a number of ships have left that route and travel *via* the Cape instead, several lines ordering their fleets to make the change before the war. Should this movement assume large proportions it may require that present plans of development be enlarged, especially in the case of Cape Town, which is the oil bunkering port of the Union.

Up to March, 1938, the total amount expended upon the harbours of the Union amounted to £18,300,000, after deducting amounts spent upon works which have become obsolete, &c. The position of the development schemes proceeding at the various harbours is approximately as follows:—

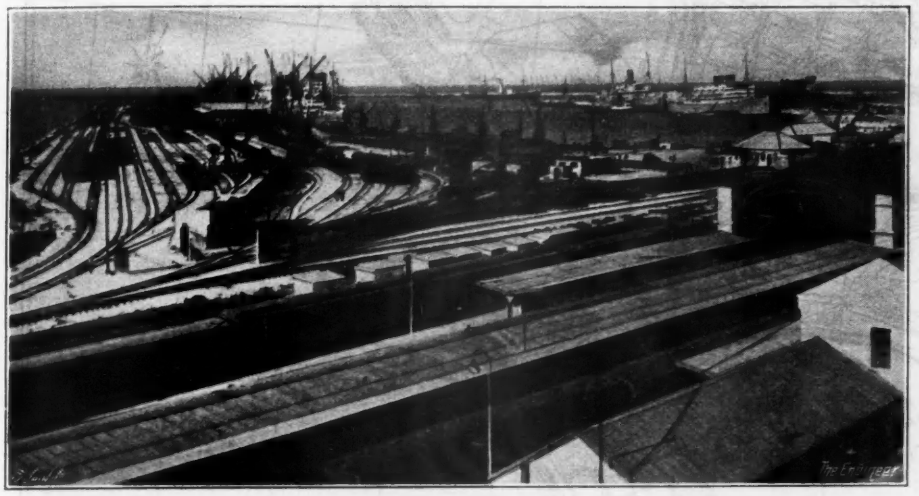
Cape Town Docks

At Cape Town the new basin, with an area of 196 acres, which was completed in 1934, is now being extended as indicated by the plan and photographs herewith. When completed, it will consist of a rectangular basin, 6000ft. long and 2000ft. wide, extending on the foreshore side to the Woodstock beach. The random block mole, shown in the plan, running down the centre of the basin, was formerly the southern side of the basin and is now in course of removal. A

new eastern mole, 40ft. wide, is being constructed from the entrance to the basin to the Woodstock beach, and was completed towards the end of June or early in July. The demolition of the old random block mole is expected to take about two years. The western or landward side of the new basin, to be known as the "Foreshore Quay," will be used for passenger ships, and it will be possible to berth five "Queen Marys" alongside this 6000ft. wharf simultaneously.

The northern side of the basin, which is already completed, provides berthing space for three ships up to 600ft. each and will be used by vessels landing or shipping general cargo or fruit. The southern side of the basin, that nearest Woodstock, will be used by vessels discharging bulk cargoes, particularly timber. The eastern or seaward arm of the basin will be used for bunkering ships as well as for working general cargoes. From the end of the fifth berth at the "Foreshore Quay," when completed, a temporary wall will be built to join the eastern mole at a point at the Woodstock beach. The whole of the area on the land side of the "Foreshore Quay" and this temporary wall will be filled in and the ground thus reclaimed will amount to 363 acres. The proposed dry dock will occupy a site on the Woodstock or the southern side of the basin, which will contain the dry dock caisson. The dry dock will be the largest in the southern hemisphere, being between 1100ft. and 1200ft. long and 110ft. wide, and able to take any ship afloat. It will have perpendicular sides, so that when it is not being used as a graving dock ships will be able to berth alongside its walls to discharge cargoes.

Of the £6,000,000 which the complete scheme is estimated to cost, £2,250,000 has so far been set aside for the first section of the work. This consists of the construction of the first three berths of the "Foreshore Quay," the building of the 7000ft. random block mole to form the skeleton of the seaward arm, the removal of the existing mole, the removal of 1,800,000 tons of rock from the sea floor to provide an average depth of 40ft. over the whole basin, and the reclamation of 16,000,000 tons of new land on which Cape Town will extend its streets, premises, &c.



MARSHALLING YARDS OF CHARLES MALAN QUAY, PORT ELIZABETH

The Railway and Harbour Administration's share of the land being reclaimed will be 127 acres. The portion which will belong to the City of Cape Town will be 236 acres, and it is estimated that this new land will be worth £5,000,000. The total cost of the reclaiming scheme, including reclamation costs, but excluding cost of streets and municipal services, will be £2,900,000, of which £500,000 will be provided by the Cape Town City Council.

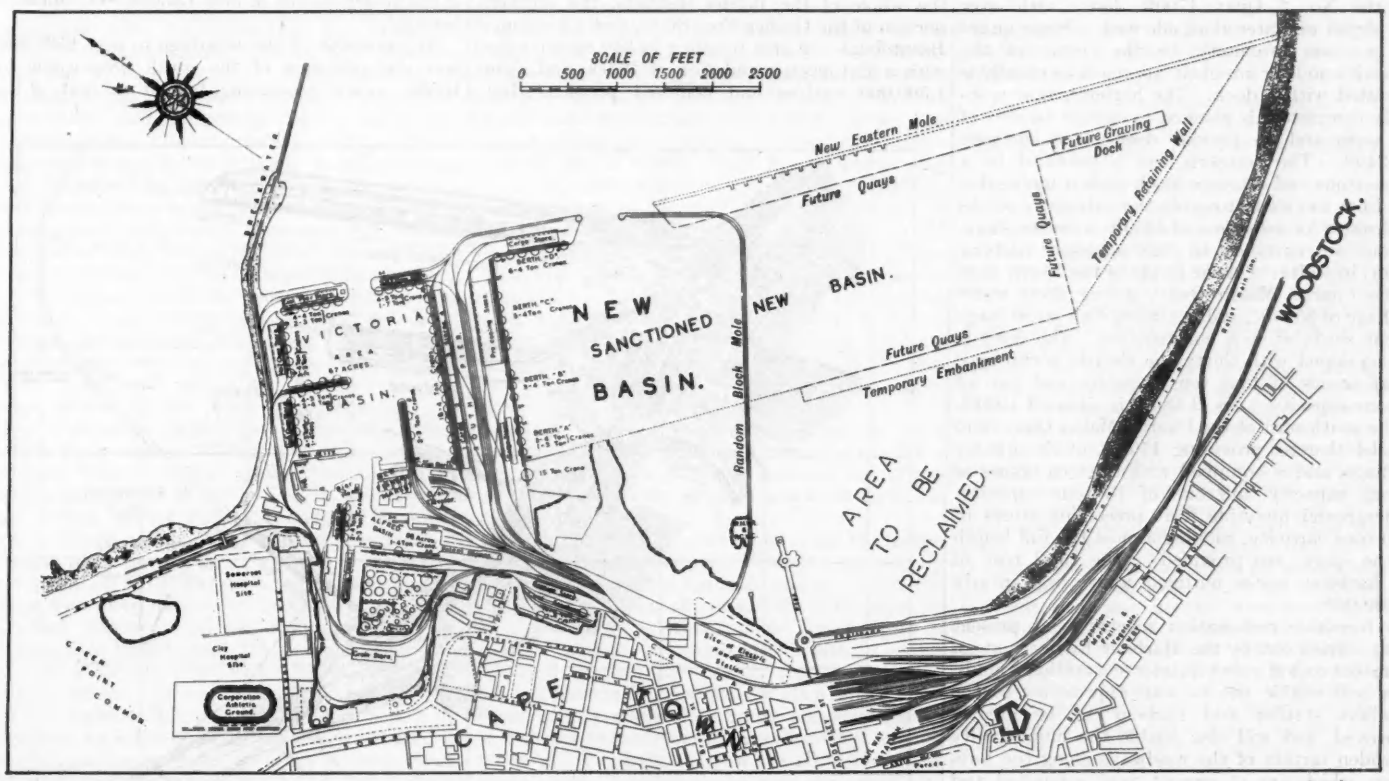
A recent tour of the work going on reveals that the entrance to the new harbour will be 950ft. wide, and thus three times the width of the present entrance. The new block mole forming the seaward side of the basin and stretching from the entrance on to the Woodstock beach, a length of 6700ft., was constructed by two contracting firms, one building 2700ft. of the mole from the Woodstock end and the other firm building the 4000ft. from the dock entrance to meet it. The task of removing the blocks which formed the random block mole, which constituted the southern side of the new basin before alterations started, is proceeding rapidly, and in the near future sufficient will have been removed to provide the new basin with an unbroken surface of water from one end to the other. Twelve "stub jetties," each 50ft. long and 30ft. wide, will shortly be attached to the inside of the new eastern mole. The future section of the harbour scheme provides for a quay wall alongside the new mole, but for the time being these jetties are being built to provide oiling berths for motor ships. Oil will be fed to these jetties through pipes which will run the whole length of the new mole from Woodstock.

It is estimated that 11,000,000 cubic yards of material will be required to reclaim the whole of the new foreshore, whereas not more than 5,000,000 cubic yards of sand and broken rock will be available from the process of deepening the new basin to 40ft. Thus much will have to be obtained from outside the harbour area. Surveying of the sea bed at the spot on the Woodstock side of the new harbour, where it is proposed to locate the new dry dock in the completed harbour scheme, is proceeding.

Main features of the city planning scheme include the shifting of the present railway goods yard at the foot of Adderley Street (the principal street of Cape Town) to a new site on the reclaimed land nearer Woodstock, at a cost of about £1,000,000; replacing the present railway station in Adderley Street with a modern one, with a courtyard in front of it on the site of the old goods yard; doubling the length of Adderley Street towards the sea, far out beyond the present pier (to be removed). It will end with gardens at the Foreshore Quay, where the big liners will tie up. In addition a large new City Hall and Civic Centre will arise on the site of the present pierhead. Forty-one large blocks of new land will be available for building and commercial purposes.

PORT ELIZABETH

Going round the coast of South Africa from Cape Town, the next important harbour is Port Elizabeth. Prior to 1930, large ships bringing cargo to that port, or loading cargo to take away, had to discharge and load to and from lighters at their anchorage in the bay. The lighterage was costly and dangerous, the steamers and lighters having to face frequent storms, and many vessels and lives have been lost. The cargo after being loaded in the lighters had to be towed to small jetties on the foreshore, and situated nearly 2 miles from the ships. With the exception that the construction of a breakwater was begun about 1919 and was



PLAN OF CAPE TOWN HARBOUR

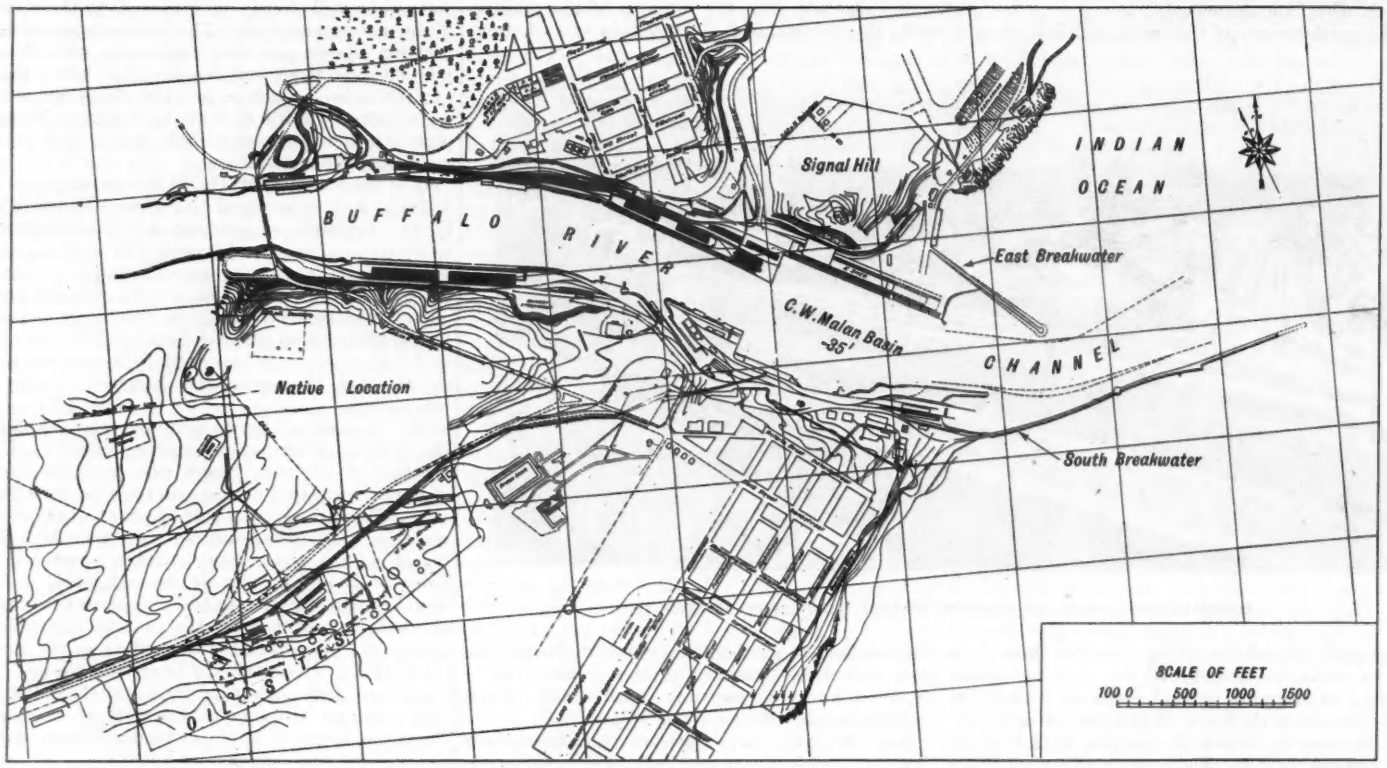
ultimately completed to a length of 4850ft. about a year ago, Port Elizabeth remained unimproved as far as its harbour was concerned until September, 1931, when a scheme, which aimed at making Port Elizabeth a magnificent harbour, at a cost of £3,000,000, was put in hand. Besides the completion of the breakwater which, as will be seen from the plan, affords adequate protection, the idea of the lay-out of the harbour, and the engraving of the Charles Malan Quay shows the marshalling yards at that quay.

East London

One hundred and thirty-one miles further along the coast eastwards is the Port of East London, known as the "Gateway to the Border and the Transkei Territories." It is the port of entry for the whole of the Border districts, the southern portion of the Orange Free State, and a portion of Basutoland—an area totalling 74,340 square miles, with a European population of 26,000 and about 1,500,000 natives and coloured people. Here, again, up to recent years all cargo from and to ships had to be lightered, the ships being anchored in the open roadstead and subject to grave danger from storms. Discharging and loading of the lighters was carried out in the Buffalo River. Later, the entrance to the harbour and the river was dredged until steamers up to 10,000 tons burden could enter and discharge at wharves.

Finally, a big scheme of harbour development was entered upon. This included widening of the river, the addition of more wharves, so that now 1½ miles of wharves stretch along both banks of the river, and the creation of a turning basin over 1000ft. square provides accommodation for a constant stream of ocean-going ships, ranging from small coasters to 25,000-ton liners, there being ample depth in the river and alongside the wharves. The expenditure of over £2,000,000 was incurred in the modernisation of East London—or Buffalo—harbour.

An extension of the wharfage to cost £562,000, and the extension of the south breakwater by 1000ft., is still proceeding, but 80 per cent. of the work has been completed. The continuous use of dredgers has been and will always continue to be necessary for digging away the sand on the bar or delving away the mud at the bottom of the river, in order to maintain sufficient depth of water for the large ships. The turning basin was opened in November, 1937, when the "Athlone Castle" entered it. Since then it has been used by the



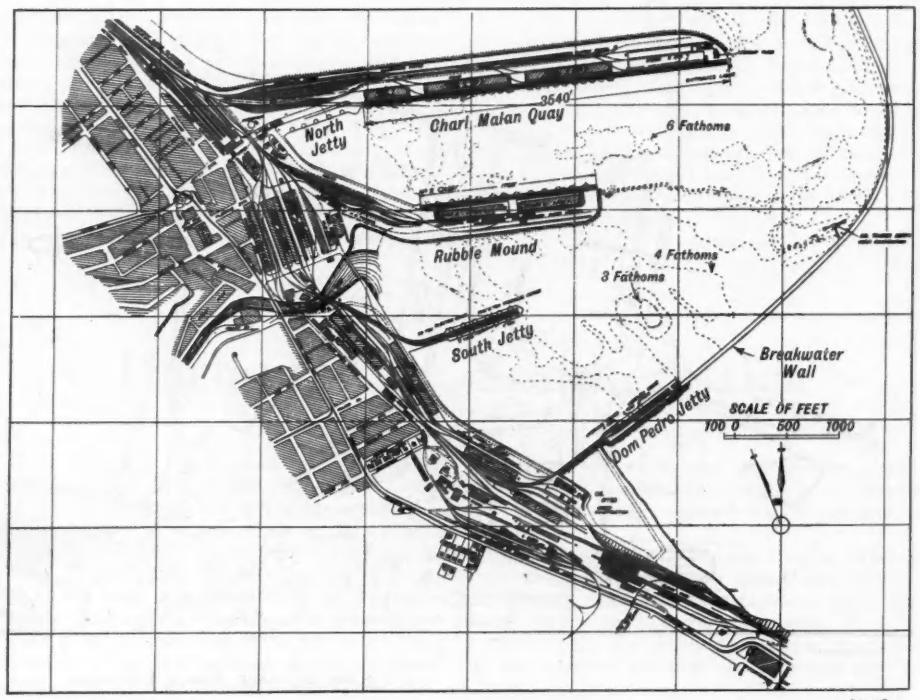
PLAN OF EAST LONDON HARBOUR

scheme provides two fine quays. The largest, the Charles Malan Quay, is 3540ft. in length, and the No. 2 Quay 1700ft. long, with over 40ft. depth of water alongside each. These quays are in close proximity to the centre of the town with no long unsightly approach as usually is associated with a dock. The harbour, now practically completed, is planned to enclose an area of 314 acres and to provide deep-water berthage of 5240ft. The northern arm is provided by a rubble stone and concrete block mole, running due east from the shore towards the extremity of the breakwater for a distance of 4950ft. from the shore, leaving an entrance to the enclosed harbour 1200ft. in width. On the inside of the North mole is the Charles Malan Quay, giving deep water berthage of 3540ft., and equipped with seven cargo transit sheds of steel construction. The quay is also equipped with thirty-one electric portal type wharf cranes of four tons capacity and two of 15 tons capacity. No. 2 Quay is situated 1000ft. to the southward of the Charles Malan Quay, and parallel thereto, providing 1700ft. of deep-water berthage, and is equipped with thirteen cranes of 4 tons capacity and one of 15 tons capacity. Underground quayside fruit precooling stores of 4500 tons capacity, running almost the full length of the quay, are provided. The total cost of the harbour works outlined above was nearly £2,200,000.

A foreshore reclamation scheme is at present being carried out by the Harbour Engineer at an estimated cost of over a quarter of a million pounds. This will enable the railway approaches to the terminus station and harbour to be greatly improved, and will also enable the municipality to widen certain of the roadways along the foreshore, which are at present very congested and narrow. A scheme for bulk oil and petrol storage within the harbour is also well in hand, the storage sites being situated on reclaimed ground immediately to the south of the old Dom Pedro jetty, and a suitable berth for oil tanker ships is under construction within the shelter of the breakwater, and designed to accommodate 12,000-ton ships.

Should traffic justify in the future, further extensions to the harbour can be constructed without difficulty by running out a third pier facing the northern side of the Charles Malan Quay, so that ships can berth alongside—protection to them being afforded by extending the breakwater.

The plan reproduced herewith gives an excellent



PLAN OF PORT ELIZABETH HARBOUR

"Dominion Monarch" (27,000 tons), which visited the port in March last on its maiden voyage to New Zealand and Australia.

DURBAN HARBOUR

Durban Harbour, 253 miles north-east of East London, is the fourth and last of the Union's large harbours. It has grown from an insignificant harbour to one of the principal ports in the world, handling to-day more than 6,000,000 tons of cargo, compared with 3,000,000 tons per annum in 1910. No other South African port has ever recorded so high a figure. As is shown by the accompanying plan, the harbour is completely land-locked, and can provide for almost limitless dock expansion. As no extensions of moment had been carried out for twenty-eight years, the necessity for providing more berthing accommodation had become very obvious, and at present the largest development programme ever launched for the port, which will involve the great expenditure of over £3,000,000, is well in hand at Durban harbour.

The main item in the new development programme is the construction of the "T" jetty, jutting out from the line of the Point wharves at the town end into the main channel near Cato Creek, and providing berths for seven large ships—on the plan, the proposed new jetty is shown in dotted lines. The jetty, which will lie at an angle of 80 deg. to the main wharves of the "Point," in the position the old floating dock occupied, will be 1980ft. long on the west side and 1700ft. on the east side, and will be 725ft. wide. There will be 40ft. of water alongside all berths.

In addition to these seven berths round the "T" jetty, two more deep-water berths are being constructed, linking it on the town side with the esplanade at Cato Creek. Their construction was started in August, 1936, and work has proceeded rapidly since. The foundations of the quay wall for the entire 1160ft. length of the two berths are complete, as is the dredging that was necessary to provide turning room for the ships to berth there. About 1½ million cubic yards had to be dredged. These combined extensions, providing nine new deep-water berths in all, will cost about £2,250,000, and in their construction approximately 3,000,000 tons of stone and rubble and some 400,000 tons of concrete will be used. The dredgers will have to remove between 6,000,000 and 7,000,000 cubic yards of spoil. For this work Durban has now the largest fleet of dredgers of any port in Africa. The other end of the Point wharves is also to be extended from "A" shed for 400ft. at a cost of £44,000. Work has already started and twenty-five of the caissons, of which the wall is to be built, have already been prepared.

Another £123,000 is to be spent in an extension of the wharf at the oil sites at Island View by 500ft. to provide a third berth. It will be constructed of steel sheet piling. A large area of shallows has also to be dredged to give turning room opposite this added berth. A special quay for whalers is to be built at Maydon wharf at a cost of £29,000. This will be an extension of the manganese and fertiliser wharves, near the graving dock, by 760ft.

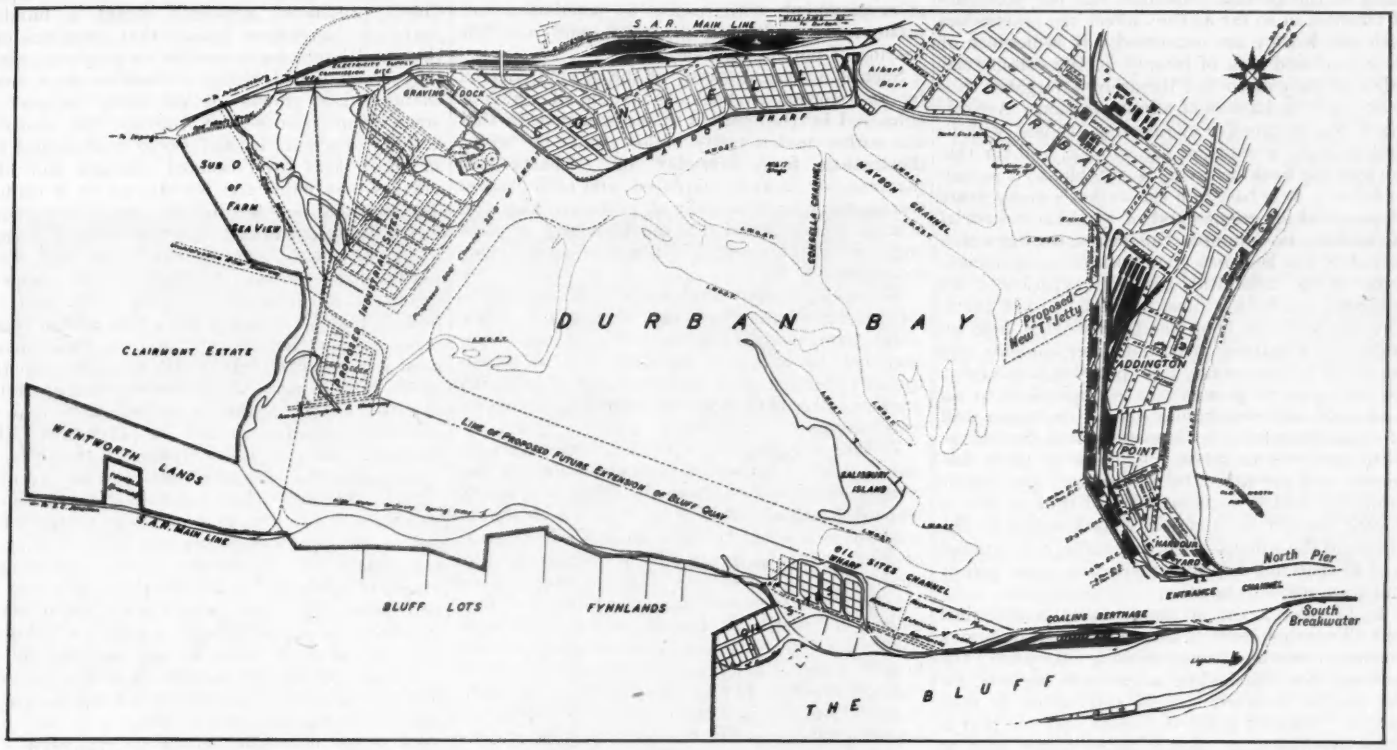
Other works soon to be put in hand are the renewal of 300ft. of the Maydon wharf by the replacement of the existing Jarrah superstructure with steel sheet piling; the reclamation of several acres of land at the Island View end of the Bluff wharf; and the addition there of grids, dumper, and extra appliances for loading coal and manganese. A great area of 1000ft. square has been excavated at a cost of £65,000 to provide a large flying boat base adjacent to the graving dock. Provision is to be made for larger hangars to be constructed and for the establishment of a modern air base where the necessary repairs and overhauling can be executed to the flying boats. The new floating dock, built at a cost of £180,000 and capable of lifting ships up to 4000 tons, is now awaiting installation nearby. The existing wall at the west side of the graving dock is to be extended, moreover, to make a repair quay 460ft. long.

Lastly, the entrance to the harbour is being improved by the removal of the cant of the north pier or breakwater. At the seaward end of the pier 600ft. are to be taken up and work on this is steadily progressing.

The total length of existing quayage at Durban harbour is approximately 19,000ft., or roughly 3½ miles. The floor space for cargo within the sheds is 706,773 square feet and the cubic capacity of the sheds is 9,198,252 cubic feet. There is outside storage accommodation with a cubic capacity of 7,216,139 cubic feet. Precooling accommodation is provided for 2000 tons at the Point, and a proposal is under consideration to provide accommodation for another 6000 tons on the new "T" jetty. There are fifty-nine wharf cranes, four of them steam and the remainder electrically operated, with a lifting capacity ranging from 3 to 80 tons. There is also a 25-ton self-propelling floating crane. Sixteen more 4-ton cranes and one 10-ton are on order. The port is equipped with five powerful tugs, fitted with modern salvage and fire-fighting appliances, four of which are fitted with wireless. There are also two smaller tugs, one of them fitted with wireless, and a pilot boat. A grain elevator at Maydon wharf has a storage of 42,000 tons and can receive and deliver at the rate of 1000 tons an hour.

The repairing facilities are at present confined to the Prince Edward graving dock at Congella. This dock, the largest in the southern hemisphere, is 1150ft. long, 100ft. wide, and has a minimum depth on the sill of 25ft. It can be divided into two sections.

When the developments proceeding at these four large harbours of the Union are completed, and all the new berths are available, South Africa will possess accommodation for ships which in every respect will be unrivalled in the southern hemisphere, and not surpassed, as far as docking facilities and up-to-date equipment for loading and discharging, by any docks anywhere, while each harbour can be entered by large ships at any time of the day.



PLAN OF DURBAN HARBOUR

Robert Henry Thurston Centenary

ROBERT H. THURSTON has been recognised as the leading mechanical engineer of his time and as the most influential educator in this field. While teaching at Annapolis, where the U.S. Navy transferred him after his period of active service in the Civil War, Thurston began to develop a plan for training engineers that would supplant the current vocational courses in mechanic arts. He put his plan into operation at Stevens Institute between 1871 and 1885, founding the first mechanical laboratory for purposes of instruction, assembling and at times inventing the necessary apparatus, and writing a pioneer manual, "The Materials of Engineering," for his students. In 1885 President Andrew D. White called Dr. Thurston to Cornell, where for 18 years he directed instruction in mechanical engineering, setting up a more comprehensive laboratory, writing additional textbooks, surrounding himself with able teachers, and establishing educational standards and programmes that set the pattern for modern engineering education. He was one of the organisers and the first president of the American Society of Mechanical Engineers, serving for two terms; three times a vice-president of the American Association for the Advancement of Science; and a member of the American Society of Civil Engineers and of numerous other technical and academic organisations in the United States and abroad. He also served on several important State and Federal commissions.

Training engineers to meet the problems of the future was a subject of perennial interest to Dr. Thurston and was the theme of an Anniversary Convocation at Cornell University on October 25th, the centenary of Dr. Thurston's birth, when many notable engineers delivered discourses on his life and work.

A NEW DANUBE TRAIN FERRY.—A report on the economic and commercial conditions in Bulgaria states that a train ferry across the Danube to be established by the end of this year, will provide the long desired connection between the Bulgarian and Roumanian railway systems. The service will connect Roustchouk (Rousse) and Giurgiu and the shore equipment is expected to be ready when the ferry boat, now under construction in Germany, is delivered.

Literature

Economics of Business Enterprise. By Walter Rautenstrauch, LL.D. London: Chapman and Hall, Ltd. 1939. Pages 445. Price 20s. net.

The subject of economics is one about which the majority of engineers have but a hazy conception, and yet most of them are expected to know something of the general principles and the problems of business in so far as they affect the enterprises with which they are concerned. It is because of their professed lack of interest in the commercial side that they often find themselves relegated to a back place in matters of administration. Accordingly, the progressive engineering student will do well to make a study of the subject, and for this purpose the book before us is suitable, as it is easy to follow; it is based on the author's many years of practical experience and of teaching industrial engineering in Columbia University, during which period he has been in a good position to appreciate some of the difficulties that are experienced by students, and he has done his best to meet them. The fact that the book has been written from an American standpoint need not deter students and engineers in this country from perusing it carefully, for the general principles are applicable to all lands, although details may vary. The upper staff of engineering factories frequently find themselves with problems to solve, analogous to those discussed, and explained by the author, who wisely limits his field of exploration, and thus is able to devote himself to a fuller consideration of the phases of the subject which he handles; it is noted that he does not deal with marketing, price policy, and transport—to mention a few omissions.

In Chapter I the economic cycle is described and illustrated, and it is clearly shown how a business works as a money-making enterprise; the necessity for marshalling all facts is stressed, for the margin between success and failure is very narrow. Another point we notice, and one that is often overlooked, is that a higher salary paid to an executive may represent a much more efficient investment than a lower one paid to a man who may be just "good enough" for the post.

Chapters II and III are devoted to the important subject of estimating costs, first the underlying principles, and, secondly, the methods employed, each being given a chapter. The author is fully justified in giving so much prominence to this question of estimating, and it is truly amazing to find how indifferently it is approached in this country, even in some big organisations. Without efficient estimating linked with reliable cost accounting, the ship of enterprise is heading for the financial rocks. In treating the very important subject of factory expense, the different methods of recovering oncost are described, although no lead is given as to which is considered the most equitable, but reading between the lines we imagine that Dr. Rautenstrauch favours the machine-hour-rate. If this is so, we are inclined to agree with him.

In Chapter IV we pass on to interest and depreciation, after which it is natural to proceed in Chapter V to the economic worth of machines, materials, and supplies, for the subjects of these two chapters are definitely complementary.

Chapters VI and VII are of particular interest, as in them the economic characteristics of business enterprise are carefully examined, and a number of specific instances in American industries are cited and discussed. As considerable prominence is given to the application of the "break-even" chart, enabling as it does the economic behaviour of a business to be judged by carefully charting important items (*e.g.*, total income and total expenses), a few notes as to its construction seem indicated. A 45 deg. line is drawn across the paper from zero, while on the horizontal incomes are plotted; by the construction of the chart vertical lines from a, a', a'' . . . meet the diagonal at b, b', b'' . . . in such a way as to represent a true value of income, in that $o\,a$ is equal to $a\,b$, $o\,a'$ to $a'b'$, and so on. If now expenses are plotted on these verticals a series of points c, c', c'' . . . will appear. If these points are joined and projected, the intersection between the line so formed and the 45 deg. line is termed the "break-even" point. Everything to the right suggests profits and to the left losses. The lengths $b\,c$, $b'c'$, $b''c''$ . . . are measures of the profits. The value of the chart will be apparent, and the range of application is wide. The author demonstrates these facts by giving a selection of charts for typical American businesses.

Chapter VIII deals with the interpretation of the financial statements of a company, and the method of arriving at the balance sheet. The principles involved are clearly enunciated, and the profit and loss account is described.

The concluding chapter (IX) treats of business enterprise on a national scale, involving problems of employment, with respect to population and production, production generally, and also the bearing of purchasing power.

Such is a general survey of the ground covered by an informative book, the value of which is enhanced by the method of presentation, in that the author makes many of his points by taking illustrations from everyday life. Charts and diagrams are usefully employed, and each chapter terminates with a number of problems, the solution of which would tax the ingenuity of most engineers, and few would be found who could score top marks!

Numerous controversial issues are broached, as for example the effect of "dumping" goods, which though advantageous to the manufacturer may not be a good business policy to pursue towards a foreign market, but this and other similar problems all tend to widen the interest in a research into economics.

We are in agreement with the author when he claims that "probably misunderstanding concerning matters of cost is greater than is generally realised," and also that "business . . . cannot be reduced to a scientific basis until it adopts units of measurement, means of measurement, and methods of measurement," but we feel it is for Dr. Rautenstrauch to define the necessary units, means, and methods. He may say that the term "overhead" is "almost as broad as the expanding heavens above," but this is largely the fault of the engineer himself. On the other hand, to his credit it must be stated that the cost accountant has set himself clearly to define the terms he uses, and the engineer might well copy the good example thus set him.

The Growth of Science. By A. G. P. Rossiter. London: Sir Isaac Pitman and Sons, Ltd. 1939. Price 5s.

This book is written in Basic English. Basic English is a device for simplifying our language by a strict reduction of the vocabulary. It has been discovered that we can get on quite well with no more than 850 words for common usage, with the addition of some 150 or so for special purposes. The rules require that if you use an outside word you must put an asterisk to it or, perhaps, explain it in a footnote. That leads to some comical results as when "rheumatism" has to be defined. But taken for all and all Basic in competent hands is a good tool. How it would serve for a completely scientific or technical work we do not know, but we suspect that it might involve circumlocutions to avoid the short cuts which scientific nomenclature provides as occasion arises. The work before us is only semi-technical. It is a book on the history of science for the general reader; it never goes deep into technology and though perforce a good many purely scientific words have to be used the author does very well within the limits prescribed. In fact the reader would hardly know that he was reading Basic if he were not advertised of the fact. We ourselves were informed recently that one of our leading articles was almost basic. We suspect that our readers were as completely unaware of the fact as were we ourselves. Which goes to show that Basic is very like ordinary English.

Mr. Rossiter has attempted to review within the limit of some 350 demy octavo pages the whole history of science and its relations with society since the coming of man upon earth. In part he is philosophical, in part encylcopædic. There are whole chapters which are little more than a string of summaries of the principal scientific events and discoveries in certain periods and in certain sciences. In these the connection between society and science is latent but not patent. In other chapters, which we found more readable, the author is philosophical. He deals specifically with the effect of the progress of science upon society as a whole. Part IX which is entitled "Darwin and After Darwin" is a good example. Another is called "Belief," which is followed by a chapter headed "Change" in which the Renaissance is summarily but effectively reviewed.

In some cases we cannot see eye to eye with Mr. Rossiter in his philosophical comments. For example in Part VII which is entitled "Measure to Power" he says that, in the early years of last century, one of the chief businesses of science was "to keep producing cheap; and its power for good has been limited by this condition down to the present day. It was not (and is not) used on any great scale for making men's living conditions better." Unless our author's words mean something to him which they do not mean to us this statement is erroneous in every respect. Cheap production certainly meant a hundred years ago, as it does to-day, that amenities of a thousand kinds are accessible to people to whom they were denied before. Consider as a single example the growth of electricity supply. It arose from science and through the constant activity of science it has become so abundant and so cheap that even isolated cottages and little villages may enjoy the benefits which it confers. To say that science is not used for making men's living conditions better is absolutely negatived by such things as sanitation and water purification, to say nothing of the achievements in medicine and surgery. The fact, we fear, is that Mr. Rossiter has a bias against profit-making from the use of science. Philosophical as he is in other respects he fails to see that whether profit is or is not made is neither here nor there. If a profit is made that is an indication that the service rendered is valued by purchasers; if it cannot be made then the evidence is that however remarkable the scientific discovery or invention may be the public does not hold it worth what it would cost. In the first case the profits which accrue to the undertaker are infinitesimal by comparison with the service rendered in the provision of commodities and in the increase of the circulation of money which they bring about. Moreover profits invariably return to industry; for enjoyment of them is only possible by the purchase of things which industry provides. The fact that there is sometimes a lag, as when a film-star buys a diamond necklace, may delay for a very short time the return of the money to industry; it cannot prevent it.

Again Mr. Rossiter states that "The discoveries which are most readily supported with the money of the public (or public money) are those producing playthings and instruments of destruction." We should be glad to see the statistics and data on which that assertion is founded.

But these evidences of political waywardness apart, the volume is one that we have enjoyed reading, and which we commend to brother engineers who like to get outside their familiar grooves. Furthermore it will be useful as a volume of references, for the author, with astonishing patience has enumerated, epitomised, and dated all the great discoveries and inventions in physical science in seven hundred years.

Electrification of Darwen Paper Mills

A noteworthy engineering achievement was recently carried out at the mills of the Darwen Paper Mill Co., Ltd., when the steam-driven plant was converted to electrical drive without loss of a single hour of production time. The opportunity offered by the September holiday shut-down was taken to effect the change-over, and an unusual feature of the work was the use, wherever possible, of the regular mill labour under the direction of the engineers responsible.

At 7 p.m. on Friday, September 8th, the "holiday" began, and with it the conversion. Everything was planned to the tightening of the last nut, and the 400 men of the mill, whose job till then had been making paper, found themselves helping millwrights or cable-jointers, hoisting heavy machinery in position or laying concrete foundations.

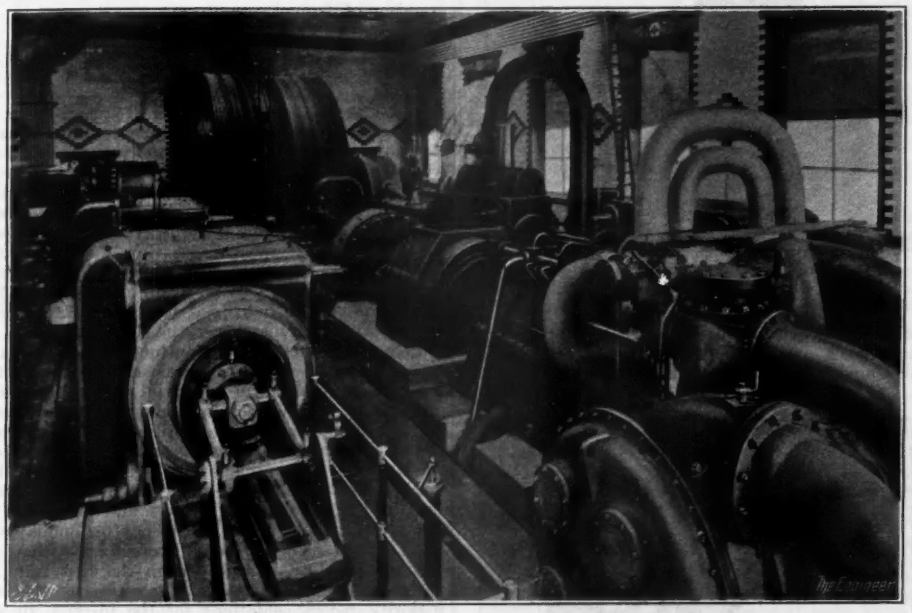
Credit is due to the mill management, the contractors, and the mill workers for the fact that the conversion was completed and the new plant running at 6 a.m. on Monday, September 18th, 227 hours after the commencement of the work. During part of the time the workers put in two shifts, and so perfect was the co-operation that not a single hitch occurred.

As is to be expected in any large job entailing the substitution of new plant for old the work was beset by many difficulties. The objects of effecting the change with as little structural alteration as possible and of retaining the maximum amount of existing machinery consistent with complete modernisation were kept in mind, and much ingenuity was exercised in dismantling and erection on a site which was not equipped for the handling of heavy machinery.

The plant as it originally stood comprised a 2500-H.P. triple-expansion pass-out Yates and Thom

steam engine using steam at 190 lb. g., 450 deg. Fah., and driving through a 70-ton flywheel and ropes two groups of beaters and a group of refiners, the main shaft for this drive being 18in. in diameter. The engine passed out 10,000 lb. of steam per hour at 20 lb. pressure. Five paper machines were also in operation, driven by vertical two-cylinder variable-speed steam engines of 250 H.P., 205 H.P., 184 H.P., 61 H.P., and 46 H.P. respectively. Their auxiliaries were driven by three 100 H.P. and one 15 H.P. single-cylinder constant-speed engines. Various drives by 230 volt D.C. electric motors were also installed, and, wherever possible, these were retained.

The new plant consists of a 3200-kW. steam turbine of the self-contained pass-out type with inlet steam conditions of 190 lb. g., 600 deg. Fah., and passing out 40,000 lb. of steam per hour at 15 lb. The economic advantage of obtaining all the required process steam from a single source will be obvious. Before the new plant was installed this steam was made up of the pass-out steam from the main engine, supplemented by the exhaust steam from the various



TURBINE ERECTED BETWEEN CYLINDERS OF TRIPLE-EXPANSION ENGINE

other engines, which were of the back-pressure type. The turbine drives through reduction gears a 2200-kW. 0·7 p.f. alternator wound for three-phase, 50 cycles, 3300 volts, direct-coupled to which is a 1000-kW., 460-volt, three-wire D.C. generator.

Through a H.T. switchboard, the alternator supplies three 800 H.P., 3300-volt, slip-ring motors for the beater and refiner drives and four 3300-volt slip-ring motors ranging from 40 to 100 H.P. The 3300-volt supply is also taken through a 200-kVA., 3300/440-volt transformer to four 440-volt A.C. motors ranging from 15 to 45 H.P.

The D.C. supply is used for the existing D.C. machines and also for five variable-speed, shunt control motors, two of 46 H.P., and one each of 184 H.P., 205 H.P., and 250 H.P., displacing the two-cylinder steam engines working the paper machines.

In preparing for the change-over, the turbine was erected and completely connected up in position between the parallel cylinders of the triple-expansion engine before this was shut down. The illustration shows the turbine in position. The switchboards had been installed in temporary positions in the engine room and all wiring laid. It had also been found possible to install two of the paper machine motors in position with their driving shafts passing between the ropes, so that on shutting down the engines driving these machines it was only necessary to change over the rope pulley from engine to motor shaft.

An interesting feature in the installation of two of the 800 H.P. A.C. motors was the method of laying concrete foundations for them. The motors had to be installed in a rope race in such a position that the pre-construction of the foundation was an impossibility. A steel grillage was therefore made and, after the removal of the rope pulleys, laid on previously prepared footings. The motors were then placed on the grillage, lined and connected up. Simultaneously concrete foundations were built up from the bottom of the rope race, and the grillage was grouted in.

The installation was carried out under the personal direction of Mr. G. Rackley, Managing Director of the mill, and of Mr. F. Stuart and Mr. T. Ellison, Chief Engineer and Chief Electrical Engineer, respectively. The whole of the new plant was designed and supplied by Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, acting as main contractors. Messrs. L. E. Wilson, of Manchester, and Messrs. T. Dryden, of Preston, sub-contracted for the wiring and mill-wrighting respectively. Alterations to steam piping were carried out by Bolton Superheaters, Ltd., and foundation and building work by John Dickinson & Co., Ltd., of Bolton.

Russian Munitions Production

WE reprint in abridged form below an article by Mr. Edmund J. Lowry in the issue for October 5th, 1939, of *The Iron Age*. This manuscript was received by *The Iron Age* on September 15th, some time before the newspaper reports of the latest German technical migration to the U.S.S.R. As a prefatory remark to the article, entitled "U.S.S.R. Still No Saar," there appears:—"After eight years in the U.S.S.R. as a munitions consultant, the author is unimpressed with the Hitler–Stalin *affaire d'amour*. Stalin has an industrial bellyache and is not likely to kick in when Hitler wig-wags for help."

AN ideological state depends on armed force to keep the people in subjection. Concurrently, the size of the armed force is plainly dependent upon the solidarity of the people with their government or the issue at stake, as well as the area of the country thus controlled. This ideological situation invites a comparison between Russia and the United States.

The armed forces of the United States is well under 500,000, with an additional million at hand for reserves. The distance from east to west would approximate 3000 miles and from north to south about 1500 miles. There are about 238,000 miles of railroads, the larger percentage running east and west. The automobile transportation roads reach a total of over 10 times the railroad mileage.

The armed forces of ideological Russia are three times as great and the reserve corps 16 times those of the democratic United States. The distance from east to west is two and one-half times greater and from north to south nearly twice that to the boundaries of the United States. However, the railroad trackage is less than one-quarter and the automobile roads less than 10 per cent. of the total in the United States.

From the comparison of these figures it is evident that Russia, *regardless of her form of government or type of alliances*, must of necessity have a large armed force. Furthermore, because of the lack of adequate railroad transportation, which may be considered as about 30 per cent of that of the United States, it is essential that bases be maintained in the east, the west, as well as the south. As an example of this necessity, take into account the fact that the rate of delivery of troop trains from east to west, in time of war, would be limited to less than 12 trains a day (approximately 60,000 men), without any provision for transport of food rations, artillery, or tank equipment. It is plainly evident, therefore, that Russia needs complete military establishments in at least three definite zones. Another vital point to consider is the speed of travel on Russian railroads. The maximum is 40 m.p.h., which means a seven-day trip from Moscow to the eastern Vladivostok section. The same or even worse conditions prevail on the western front.

Hence, the railroads become an essential in considering the munition manufacturing ability of Russia, as well as in its contention of being a major military power. Because of transportation deficiencies Russia has established 13 military districts, each having its own railroad centres. These districts are an essential to the life of the Soviet because through them order and obedience to the Stalinist government is maintained.

It must be borne in mind that the masses in Russia are frequently at odds with government policy. This naturally affects production for the armed forces. It must likewise be remembered that Russia is a stripling in the industrial sense, and that it is impossible to scientifically project a people 50 years ahead of their time. Peasants cannot be made into mechanics by decree. And, it must not be forgotten that England, France, and the United States exploited Russia with manufacturing concessions. Finally, the fact must not be overlooked that Russian temperament lends itself poorly to being cooped up in factories, foundries, forge shops, etc. The Russian is of an artistic nature that craves the freedom to sing, to dream with vodka, and to dance as he entertains at lavish dinners.

With his limitations and outlook the stuttering progress of the five-year plans becomes understandable.

Buildings, buildings, and yet more buildings amaze the eyes of visitors to the Soviet. Foreign machinery on end fill these enormous modern structures. Inventory galore, supposedly ready for shipment, is stacked up on all sides. This inventory is inspected and divided into three categories: first, the best for the military; second, the passable for export; and third, or the little that remains, for domestic use.

True, the Heavy Industry group is not the mainstay of the army's material production, but all the factories in Russia are regimented so that at a moment's notice they may be switched from domestic and export production to the military. There is a "secret" department, which is composed of members of the O.G.P.U. and a number of military aides, which positively controls the movements of the work in the shops. This appointed clique can go so far as to break up the normal "flow" of production and rearrange the normal layout of the mechanical equipment or devices, such as conveyors, in order that the plant can be immediately turned over to the production of cartridges, belts, leggings, etc.

This is a major reason why some of the shops in the Soviet are constantly inefficient. Stalingrad or Cheliyabinsk, two of the world's largest tractor factories, produce only half of what factories in the United States of equal capacity can produce, the latter having much less floor area and half the labour force. But these gigantic Soviet factories could be turned over to small tank production, almost at the wink of an eye. Efficiency in these cases is partially sacrificed for the future protection of the country.

In addition to the regimented industries, the army (the entire armed forces of the Soviet) has its "secret" plants. These plants are the real munitions producers of Russia. Instead of names, numbers designate them, such as Savod 22 or Savod 28. Savod in Russian means a factory and the word is applied to any type of plant in the U.S.S.R. There are in all over 375 of these "secret" plants scattered over the country.

It will be remembered that in the World War of 1914, Russia was the poorest equipped of all the nations. Consequently, the new regime laid great stress on the development of industries for the manufacture of war materials. This came under the heading of "defence of the proletariat." The workers gave and gave willingly to build up this fortress of strength. And the government took every advantage in accomplishing this essential project. The disadvantages, apparent from the first, were the lack of qualified technicians and skilled labour. Lenin therefore sought the aid of the Germans. These foreign engineers little understood the situation in the Soviet; nevertheless they proceeded with a will and concentrated their efforts in building the munition industry about the large cities such as Moscow, Leningrad, Kharkov, Kiev, etc. These cities are now the capitals of the western Republics of the U.S.S.R.

The military plants are now built in cleverly hidden sections around Moscow and the chief cities of the Soviet. The present locations present a better technical decision, for each military section is practically self-sustaining from the standpoint of war materials. However, production has never been based on 100 per cent.; therefore, the results are far from engineering perfection.

As far as sabotage is concerned, the writer must say that he never actually saw one case. What did happen could have been charged to acts created by ignorance or a desire to learn from investigation. Many people held and still hold that the wrecking charges introduced into the theatrically manœuvred trials *were the outcome of carefully planned movements against the government*. After eight and one-half years of close contact with the Soviet government in completing 55 projects, the writer can honestly say that the wrecking charges should have been credited to the gaining of experience in the industrial life of a mechanically backward country.

Sabotage or wrecking comes under several headings. For one, the small production achieved by a planned economic policy could be mentioned. The Savod Gorki is a facsimile of the River Rouge plant of the Ford organisation. This Gorki plant was designed to produce 230,000 motors a year, with the same number of employees as the great Detroit plant. But with twice the employment it turned out only 60,000 motors. Ten per cent. of the motors passing the highest test belong to the war department. The balance, up to those that fail to function, are distributed about for various uses. The Gorki plant is now being expanded to twice its original size to accommodate an objective of 250,000 motors a

year. The writer was a consultant for this particular project and objected to the expansion (Izvestia, April, 1936) on the grounds that the problem of production could not be solved by size alone.

The airplane industry is a case where the present plants should be able to produce 3000 planes a month. Here again are the same paralysing conditions of quota shading off into wishful thinking. And these plants are dominated by American specialists who hold concession rights granted by the Soviet government. Yet the maximum production is less than one-third of the rated capacity and the hours in the air discredit even this production. Tanks fall into a similar category. Well housed and equipped for production, this industry shows a production rate that baffles the engineer, for quota is approximated but performance is disheartening.

In the munition field, requested competitive tests of foreign equipment proved that the Soviet scored 55 per cent. against the American equipment. This test encompassed mobile equipment guns, rifles, and chemicals. For an example Soviet mis-fires were over 45 per cent., or about the equivalent of American mis-fires back in 1916. The condition persists because there is no real technical aid available. Furthermore, the peasant has not been trained to the accurate boring of a rifle to 0·001 deg. Explosives are uncertain. The present munition chemist must rely upon data sometimes 20 years out-dated. And the Russian technologist, lacking proper supervision, is frequently lost in a mass of instructions that mean nothing to him.

In many ways Russia is self-sustaining, but is deficient in certain war materials. These necessarily must be imported. Included in this group are purified copper, purified aluminium, nickel, molybdenum, tin, graphite, nitrates, and zinc. These, of course, are essentials in the munition industry.

Consulting the export and import lists of Russia will lay the ghost of the Soviet being self-sustaining at the present time. The writer recently noted that sleeves for airplane motors were imported and other items that he was unaware of, such as raw material which they possess in known quantities.

Russia has bountiful supplies of natural resources and she should emerge from the sticky condition she is in—if her ideology permits. The non-aggression pact with Germany, if continued, will doubtless assist in correcting many of the faults in production. German technicians and mechanics will greatly improve matters. *Probably an exchange of raw materials for technical aid is visualised in this pact.* The democracies can well suspect such a course, with the full knowledge that it indicates an expanded danger. At the present time Russia needs her munitions for home use. She can't afford to jeopardise the safety of her borders nor risk the hazard of domestic revolution by depleting her own marginal needs. Hitler was well aware of this before he entered into the pact, and it's safe to assume that he will do something about it.

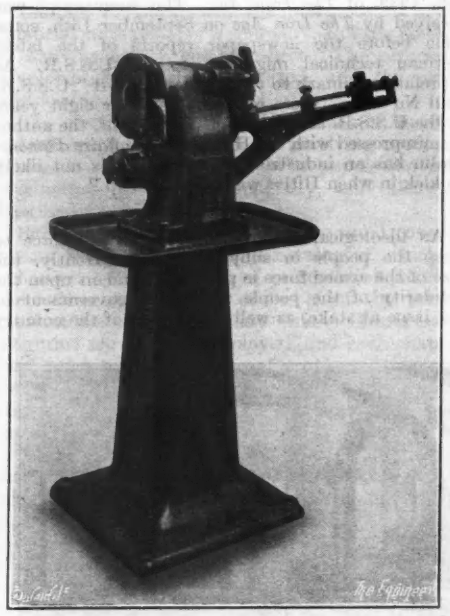
Ideology, lack of mechanical feel, persuasive force, or whatever the trouble or troubles may be, as a consultant in the munition industries of Austria, Czechoslovakia, France, Sweden, Germany. and England, the writer has never come in contact with such a low equivalent in productive methods as exists at the present time in Russia. Currently, the Soviet can make no formidable contribution of munitions to any ally. During the months to come the picture can and will doubtless change.

Improved Twist Drill Grinder

The improved model of Edgwick twist drill grinder, illustrated herewith, was designed after a careful analysis of the varied requirements of machines of this class. In designing a twist drill grinder the complicated geometry of the swinging arm always presents certain difficulties in obtaining the most efficient results. Tests were carried out which proved that only very slight variations in point angle and lip clearance affected very considerably the accuracy, number of holes per grind, and the power consumption of the drills ground on the machine. The design of the arm, which by numerous tests gave the most efficient results, was adopted and it is claimed that the drills are ground with the most efficient lip clearance and with equal angles and lengths of cutting edges.

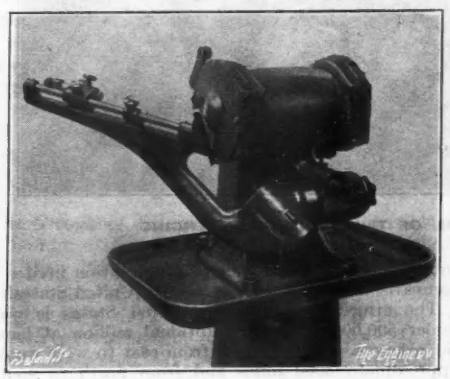
The grinder is a self-contained motor-driven machine capable of grinding any two-flute twist drills from $\frac{1}{8}$in. to $1\frac{1}{4}$in. diameter. The vee rest and holder can be instantly adjusted to suit the drill length. Feed is applied by means of a fine thread screw and the centre vee rest is adjustable along the whole length of the trough; thus the two supports can be placed at the maximum distance apart to give good alignment. Adjustment is provided to vary the lip clearance to suit different materials to be drilled. An accurate diamond-truing device with a screw adjustment is provided to dress the face of the wheel true in relation to the setting of the arm so that consistent results can be assured. The action of the drill on the face of the wheel gives a self-dressing effect so that repeated dressings are unnecessary.

The rotor-stator unit forming the motor is housed in a one-piece casting which protects it from dust. Stop and start push buttons are fitted in a convenient position on the front of the machine. The ball-bearing spindle carries a 7in. cup wheel for sharpening



TWIST DRILL GRINDER

the drills and one 7in. disc wheel for point thinning. The wheels are adequately guarded and exhaust ducts are provided. The machines are made exclu-



SWINGING ARM AND DRILL REST

sively for Alfred Herbert, Ltd., under its supervision, by a well-known British firm.

Sixty Years Ago

The Coalbrookdale Bridge

In the course of an article on the newly opened Severn Bridge and its railway, which appeared in our issue of October 24th, 1879, we reviewed the history of the numerous proposals which had been made for the construction of a bridge across the river to connect Gloucestershire with South Wales. Incidentally, we remarked that by a curious coincidence it was exactly one hundred years since the famous Coalbrookdale Bridge at Ironbridge was completed. This structure still spans the Severn above Gloucester, and is famous not only as being the first iron bridge to be built, but for the beauty of its design. It is of cast iron. In our remarks concerning it we commented upon the uncertainty prevailing in the matter of the name of its designer and constructor. All authorities agreed that it was made at the Coalbrookdale Works, but there was wide disagreement as to who was responsible for it. Gauthey attributed it to John Wilkinson and Abraham Darley (*sic*), Fleeming Jenkins ascribed it to Abraham Darby, Smiles credited it to Richard Reynolds, and the *English Cyclopedia* gave it to a Mr. Pritchard of Shrewsbury. In our succeeding issue the point was set at rest by a "Letter to the Editor" from Martha Frances Darby, writing from Bwlch, Brecknockshire. She stated that her grandfather, Abraham Darby, designed and constructed the bridge, being at the time the managing partner of the Coalbrookdale Company. The history of the bridge, she said, had been confused with the names of neighbouring gentlemen and ironmasters who had bought shares in its capital. She possessed a gold medal of the Society for Promoting Arts and Commerce instituted in London in 1754. It bore, she said, the inscription: "To Abraham Darby, 1787, Model of Coalbrookdale Iron Bridge, presented," and, below a wreath, the letters "N. CLXXI." The inscription on this medal was, no doubt, arranged circularly, in which case, we suggest, it should have been read with "Model" as the first word. We confess, however, that we have no interpretation to offer of the letters below the wreath. Our correspondent's letter also contains something of a genealogical puzzle. She stated that Abraham Darby was her grandfather, but in her opening sentence she described herself as the widow of an old subscriber of the same name, Abraham Darby, of Ebbw Vale, and she signed her own name as "Darby." The clue may, perhaps, be found in the three following sentences which we take *verbatim* from her letter. "Abraham Darby died at the age of thirty-nine—and his eldest son also—in 1789 during a severe epidemic of typhus. His only brother, Samuel Darby, younger than himself, died in 1796. The sons of both were very young children." Two solutions seem possible. She was the grand-daughter *by marriage* of the bridge designer; or she was his full grand-daughter and had married her second cousin Abraham, the grandson of Samuel.

Railway Wages

On Saturday, October 21st, the findings of the Railway Staff National Tribunal on the claims which were recently put forward by the three railway trade unions were made known. The Tribunal has a divided opinion on the claim put forward by the National Union of Railwaymen, with regard to the minimum rate of 50s. for all grades. Sir Arthur Salter, the chairman of the Tribunal, and Mr. H. J. May, recommend a minimum rate of 50s. in London, 48s. in industrial areas, and 47s. in rural areas. The third member of the Tribunal, Mr. H. E. Parkes, recommends the continuation of the 45s. rate for men in the rural areas, an increase of the minimum to 46s. 6d. in industrial areas, and to 48s. in London. For women he suggests minimum rates of 35s. (an increase of two shillings) in rural areas, 36s. 6d. in industrial areas, and 38s. in London. The Tribunal is unanimous with regard to all its other findings, and these include an increase in the minimum rate of 12s. per day for drivers and motormen to 13s. a day, and modifications to pay for Sunday and night duties. The Tribunal recommends that the findings should take effect from the first full pay period from October 28th. It is estimated that the majority recommendations for the increase in the minimum wage will directly cost £414,000 a year, and that the consequent advance to bring other wage rates into due relation will cost about £350,000. The increased wage for drivers, in their first and second years, will cost £39,000, the changes in Sunday duty payments £150,000, and the additional night duty payments to clerical staff £58,000. In total, therefore, the direct effect of the findings would add £661,000 a year to railwaymen's earnings, and consequentially nearly £350,000 more, making over £1,000,000 altogether. The findings of the Tribunal are not binding on the parties and we understand that there will be no meetings of the unions to decide upon their action.

"The Model Engineer"

We desire to offer our hearty congratulations to *The Model Engineer* on the appearance of its two thousandth number and the special issue which celebrates that event. "The spread of model engineering has been remarkable," says the Editor. "The handful of enthusiasts who formed the first readers of *The Model Engineer* have grown into a community of many thousands living in all parts of the world, all animated by an intense love of engineering in one or other of its many branches, and by a desire to reproduce in miniature a prototype which has aroused their admiration, or to give practical shape to designs which emanate from their own practical instincts." All that is perfectly true. The love of model making is inherent in man, and the spread of technical knowledge, of handicraft, and the cheapening of machines for the model workshop have all helped to foster it. Model making keeps pace with its prototypes; the aeroplane and the speed-boat have not encroached upon the territory of the locomotive, the steam engine, and the steamship, but have only added to the number of model makers. When the brothers Marshall laid the foundation of *The Model Engineer* forty years ago, they could not have foreseen what the future held in store, but that they built wisely and well is made evident by the continued prosperity of a little paper which is known, respected, and, let us add, loved by the engineers of the miniature all over the world.

Projected Exhibits at Olympia—Errata.—Under Fig. 138 in last week's issue the name of the firm should have been given as Stream-Line, and not Streamlined. Fig. 149 should have been entitled Gilled (not Filled) Economiser Tubes; and Fig. 152 Self-Sealing (not Self-Scaling) Joint.

Rail and Road

ROAD ACCIDENTS.—Grave concern has been expressed by the Minister of Transport as a result of the great increase in road accidents in this country, particularly as a result of the black-out at night. During September, 1130 people were killed on the roads as compared with 554 in the same month last year.

PARAFFIN FUEL AND MOTOR VEHICLES.—An order has been made by the Secretary for Mines prohibiting the use of paraffin, either alone or mixed with motor spirit or Diesel oil, in any motor vehicle. Exception is made in the case of agricultural tractors or engines which are permitted to be on roads only when engaged in farming work.

A NEW ROAD IN ETHIOPIA.—A considerable amount of traffic is said to be using already the new 861 kilometres long road, which connects the Red Sea port of Assab with Addis Ababa. In the construction of this road, which was opened in August, 7,460,000 cubic metres of earth was moved, 80 large and 1054 small bridges built and 340,000 cubic metres of concrete used. It has an overall width of 9 metres of which 7 metres is surfaced for heavy traffic.

THE ROAD RAIL TRAFFIC SCHEME.—In connection with the Government's new road rail scheme the Minister of Transport was recently asked for an assurance that the railways would have sufficient material to handle the increased volume of traffic that they would be called upon to handle. In his reply the Minister said no scheme would be prepared which would divert more traffic to the railways than they could handle. An effort is being made to co-ordinate road and rail transport in the national interest.

TRAIN LIGHTING.—Following a series of experiments, it has been decided to instal lights, sufficient for comfortable reading purposes, in long distance corridor stock in this country. The lights are permitted upon condition that the carriage blinds are kept drawn during the black-out period, and that the lights may be extinguished by a master switch in the event of an air raid. Further investigations are to be made before the lighting of suburban trains is improved, owing to the difficulties entailed as a result of using non-corridor stock and the frequency of stops.

ELECTRIC HEATERS FOR STAND-BY LOCOMOTIVE BOILERS.—In order to reduce the time required to raise steam in spare steam locomotives held for emergency service, the Swedish State Railways are making experiments with electric heaters for the boilers, according to the Electric Traction Supplement of the *Railway Gazette*. An electric resistance boiler is placed near the locomotive, and pipe connections are made in order to maintain a constant flow of hot water. By this means a pressure of 85 to 110 lb. per square inch, and a temperature of 150 deg. Cent. is attained near the firebox comparatively quickly, and the remaining pressure can be attained in about another 15 min. by starting up the coal fire. The electric boiler used has a nominal output of 45 kW at 800 to 1000 volts and has an overload capacity of 90 kW. It is fitted with an automatic temperature-control system.

NEW EQUIPMENT FOR CANADIAN RAILWAYS.—According to reports in the *Canadian Engineer* orders to the value of 25 million dollars are to be placed for new railway equipment to be shared by the Canadian National Railway and the Canadian Pacific Railway. The orders, which are principally for freight cars and locomotives, are to be completed within six months, first deliveries being expected within three months. The object in placing a large order now is to enable the railways to meet the abnormal demand expected because of high freight rates, increased insurance rates, and scarcity of shipping. Freight now routed by water from Vancouver through the Panama Canal will be sent across Canada, it is stated. It has been learned that the Government is anxious to have all the railway requirements completed as soon as possible so that the plants now making equipment can be transformed into munition plants if required.

ROAD TRANSPORT IN EGYPT.—A report on the economic and commercial conditions in Egypt by Mr. C. Empson, says that no solution of the long standing road-rail controversy in that country has yet been reached. He says that in 1937 the Road Association of Egypt was formed to represent the road transport industry and affiliated interests, and this Association has been urging the authorities to formulate a co-ordinated policy in regard to transport generally. In March, 1939, a Transport Advisory Council was constituted for this purpose by the Government with representatives of the various ministries and departments concerned, including the Egyptian State Railways. It is significant, says Mr. Empson, that the present restrictions on road haulage have had the effect of reducing the number of commercial lorries and buses operating in Egypt from 5323 out of a total of 29,249 motor vehicles licensed at the end of 1932, to 4,074 out of 33,456 at the end of 1938.

COLLOIDAL FUEL FOR MOTOR CARS.—Experiments are being carried out in the United States by Dr. F. W. Goodwin, of the Research Foundation of the Armour Institute of Technology, on the use of colloidal fuel for standard motor cars. In a demonstration in which one type of colloidal fuel was used, no change was made in carburation or in the ignition system except that one fine screen filter was removed. For this demonstration, according to the *Automobile Engineer*, a very light oil with a light fraction of hydro-carbon was used with a suspension of coal of about 500 mesh. In each case, before the "liquid coal" was introduced into the auxiliary fuel tank on the automobile, it was chemically stabilised to hold the coal in suspension. The automobile was then started on petrol and, after smooth running had been attained and the engine warmed up, the petrol was cut off and the "liquid coal" introduced in the carburettor. The car quickly accelerated to 35 miles per hour in second gear. It is estimated that a further year's research work is necessary before this fuel will be ready for the market.

Miscellanea

ELECTRICITY IN MINES.—According to the annual report of the Electrical Inspector of Mines there was an increase of about 82,000 H.P. in motors in the mines of this country last year, bringing the total installed motor capacity to 2,244,000 H.P. Of this total 1,198,000 H.P. was below ground. Electrical coal-cutting machines were in use at 927 mines, there being 5106 machines installed as compared with 2623 compressed air operated machines.

COAL OUTPUT OF GREAT BRITAIN.—During the second quarter of the year the output of saleable coal in Great Britain totalled 55,304,315 tons, and the quantity disposable commercially was 51,392,526 tons, of which 12,883,343 tons was shipped for export and foreign bunkers. The proceeds averaged 17s. 4·12d. a ton, or a total of £44,566,430, the net costs of production being £42,220,737. The number of workpeople employed was 739,621, and the output per man shift worked was 22·75 cwt.

PETROL ENGINE CONVERSION.—At the last meeting of the Metropolitan Water Board it was reported that experiments have been carried out at the Hampton works on a device for enabling petrol engines to be run on paraffin oil. It was ascertained that by this means fuel costs could be reduced by 60 per cent., and it was decided to fit the device to three engines which are used for widely different purposes so that the efficiency and reliability could be further demonstrated. The report points out that the fitting of the device with necessary alterations to the exhaust and induction piping costs £25 per engine.

ON GETTING-ON.—"The man who improves his position and gets on to-day is the one who knows a good deal about a great deal: who arranges his life to get the most out of his activities in every sphere," wrote Mr. John F. West in an inaugural address to the students of the Manchester Association of Engineers. "He is the specialist who seeks to know at least the principles and objects of every other specialist. Even under modern conditions there is time for it all. The same advances which have increased our facilities for amusement have increased our facilities for acquiring knowledge, and have provided leisure for a due proportion of both."

PRESENTATION TO DR. RUSSELL.—At the meeting of the Council of Faraday House on September 20th, Mr. F. Smith, the President, on behalf of thousands of Old Students all over the world, and in commemoration of Dr. Russell's 50 years' connection with Faraday House, presented him with a Ferranti Televisor, cheque, and a signet ring. He congratulated Dr. Russell on his long and successful career at Faraday House. In reply, Dr. Russell said: "I cannot find words sufficient to do justice to my appreciation of your presents. The televisor has already come and the aerial been fixed. It affords myself and family and friends continuous pleasure. Whenever I wear the ring I shall think of my old students, and the cheque will be most useful in these hard days for possible extension of the radio. I cannot imagine any presents which would have pleased me and my family more."

JUNIOR INSTITUTION OF ENGINEERS AWARDS.—The Council of the Junior Institution of Engineers has made the following awards in respect of papers and lectures delivered during 1938–39:—The Institution Gold Medal: To H. J. N. Riddle for his paper "Thermionic Valves." The Institution Silver Medal: To R. Lowe for his paper "Alloy Irons in Engineering." The Vickers Gold Medal and Prize: To D. Taylor for his paper "Steel and the Engineer." The Tookey Award: To R. Wailes for his paper "Woad Mills." The Past Secretary Dunn Medal: To K. W. Willans for his lecturette "The possibility of Solid-Fuel-Fired Marine Steam Units for powers up to 150 B.H.P." The Midland Local Section Silver Medal: To H. S. Walter for his paper "The Development of Pottery Firing." The Sheffield Local Section Silver Medal: To W. R. Gutteridge for his paper "The Abrasive Wheel and Modern Grinding."

GRANTS IN RESPECT OF AIR RAID SHELTERS.—The Minister of Home Security announces that his Department is ready to receive applications for the payment of the Government grant provided under the Civil Defence Act, 1939, to occupiers of factory premises and owners of commercial buildings in the specified areas who have completed the provision of air raid shelter in fulfilment of their obligations under the Act. Forms on which grants may be claimed have already been issued and may be obtained by occupiers of factory premises from the District Factory Inspectors, and by owners of commercial buildings from the Local Authority of the area in which the building is situated. It is stated that a large number of claims is anticipated, and it would materially assist the Department if application by those who have completed their shelters is made as soon as possible. Applications for grants will be dealt with in rotation.

ENGINEERS AND MILITARY SERVICE.—Steps have been taken to ensure that members of all classes of the leading Engineering and Professional Institutions, when called up for military service, either as Militia-men or for compulsory war service, will be posted to Units in which their services would be best employed in the national interest and, in the case of Graduates and Students, to Units in which the training will be of use to them on returning to civilian work. The authorities have given special instructions to "interviewing" officers that a note should be taken of anyone who comes before them who is a member of any such Institution, so that "posting" officers will know how the member's services can be used to the best advantage. Members of any class, therefore, should specifically mention that they are members when supplying particulars of their qualifications to "interviewing" officers and to indicate then their desire to join one of the Technical Units, such as the Royal Engineers, the Royal Corps of Signals, the Royal Army Ordnance Corps, Searchlight Units, etc. In order that members may be able to leave with the "interviewing" officer some documentary evidence of membership, the Secretary of their Institution will be pleased to supply to a member, on request, a letter stating his class of membership.

Air and Water

SHIPPING CONTROLLER FOR INDIA.—Sir George Campbell has been appointed Shipping Controller for India and also the representative of the Minister of Shipping in India.

MINISTRY OF SHIPPING APPOINTMENT IN CANADA.—The chairman and president of the Canadian Pacific Railway, Sir Edward Beatty, has been appointed to represent the British Ministry of Shipping as Controller of Shipping for Canada.

ALEXANDRIA HARBOUR.—Development schemes in Alexandria harbour are under consideration and in the 1939–40 budget of the Egyptian Government preliminary allocations were made towards the construction of a petroleum basin; the deepening of the entrance to the Harbour and the building of new customs sheds.

PROPOSED ORDERS FOR AIRCRAFT.—Reports state that if the American arms embargo is repealed the British and French Governments intend to place orders to the value of nearly 90 million pounds for 5750 aeroplanes with firms in the United States. The reports add that, should the embargo not be lifted, the British Government will invite United States' firms to establish branches in Canada.

MINISTRY OF SHIPPING ADVISORY COUNCIL.—When the Minister of Shipping, Sir John Gilmour, met representatives of the officers and men of the Merchant Service on Friday, October 20th, he said that a Ministry of Shipping Advisory Council is to be set up. Invitations are being issued to proposed members of the Council, and it is understood that its composition is shortly to be announced.

GERMAN AIRMEN RESCUED.—The collapsible rubber boats carried in German bombing aircraft have proved their value. After the recent raid on Rosyth, two men from a machine that had been brought down floated ashore in one near Whitby. Last Tuesday, a British warship picked up two survivors who had been afloat for as long as three days. It is believed that they had taken part in the abortive attack on a British convoy on the previous Saturday.

THE NORTH ATLANTIC AIR MAIL.—The Postmaster-General announces that with the completion of the scheduled programmes of flights by the British and the United States air services from the United Kingdom to North America on the Northern route *via* Newfoundland, air mail correspondence for the United States of America, Canada, and Newfoundland is now being forwarded by the United States air service which is being operated twice a week from Lisbon to New York *via* the Azores.

ITALIAN SHIPPING.—A report on trade and industry in Italy says that the shipyards are busy carrying out the shipbuilding programme approved last year by the Government toward the cost of which it provides ten annual subsidies of 100 million lire each. In addition to seven new passenger and cargo boats now being built for the main traffic lines, 120,000 tons of cargo shipping is to be constructed. In 1938, Italian shipyards laid on the stocks 119 ships of a gross tonnage of 122,914 and launched 126 of a gross tonnage of 106,248. In the first half of the current year 36,864 tons of shipping were laid down and 36,783 tons were launched, and on June 30th, 83 ships of a gross tonnage of 153,742 were being built.

BIG NEW AIRPORT IN AMERICA.—Rapid progress is being made in the construction of a large new airport near Washington in the United States. It is being built on reclaimed land on the west shore of the Potomac River at Gravelly Point. The original swampy ground was enclosed by levees and the area is being filled with clean sand and gravel pumped in by suction dredgers from the bottom of the river. When completed the airport will cover 742 acres, of which 491 acres will be landing field, including 325 acres formerly covered by water at high tide. Landing facilities will include a main north–south runway 6875ft. long, a north-west—south-west runway 5300ft. long, each 220ft. wide, and two narrower runways 4820ft. and 4200ft. long respectively. The central terminus building will be connected with the runways by a number of paved taxi-ways having a total length of 11,000ft.

NEW LIFE-BOAT FOR RHYL.—A new motor life-boat which the Royal National Life-boat Institution has built for its station at Rhyl has been delivered. The new boat is of the surf type, the lightest type in the institution's fleet. She is 32ft. long, weighs just over 4 tons, has two 12 H.P. engines, and is driven, not by propellers, but by Gill jet propulsion. The life-boat is driven by two jets of water which give her a speed of 6½ knots. She can travel nearly 90 miles at full speed without refuelling; has a crew of seven men; and can take 15 people on board in rough weather. The boat is a gift from Liverpool and will be named "Gordon Warren." She replaces the last of the tubular type of pulling and sailing life-boat. This type is a life-boat with a double hull, consisting of two floats, meeting at each end, with a grating deck in between. Its designer was a Welshman and Rhyl has had life-boats of this type since 1856.

AN UNUSUAL STEEL POONTON BRIDGE.—In a recent issue of *Engineering News Record*, Mr. E. R. Wiseman describes an unusual steel pontoon highway bridge which has been completed across the Golden Horn at Istanbul, Turkey. At this place, the depth of water varies between 65ft. and 130ft. and this, combined with a sea bottom of soft clay at least 100ft. deep, prevented the economic construction of foundations. About 1500ft. long and 82ft. wide, the new bridge consists of two end sections of ten pontoons and a centre section of four pontoons designed to be moved out of position by tugs to allow the passage of large vessels at certain hours of the day. The pontoons are 82ft. by 30ft. by 11ft. deep, are spaced about 30ft. apart, and support a rigid frame superstructure. Each pontoon is divided into nine watertight compartments. In case of damage to one of the pontoons, it may be removed for repair and its place taken by two spare pontoons being moved into the openings on either side of it to provide a temporary support for the superstructure.

PROJECTED OIL ENGINE EXHIBITS AT OLYMPIA

(*For description see page 427*)

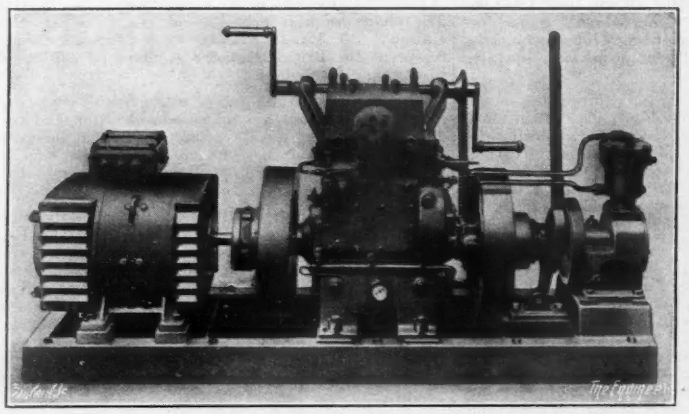


FIG. 153—AUXILIARY GENERATING SET AND COMPRESSOR—RUSTON

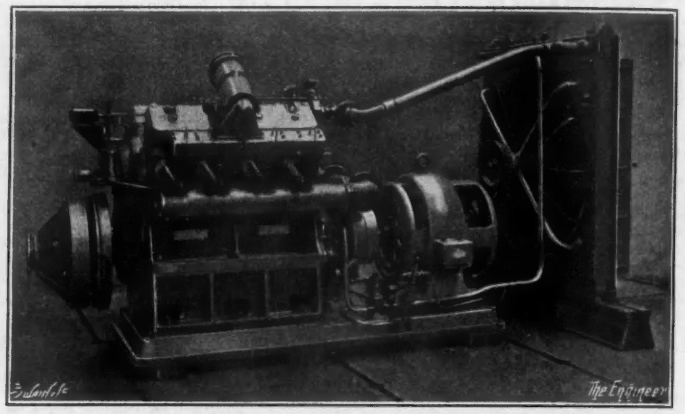


FIG. 154—400 H.P. GENERATING SET—DAVEY, PAXMAN

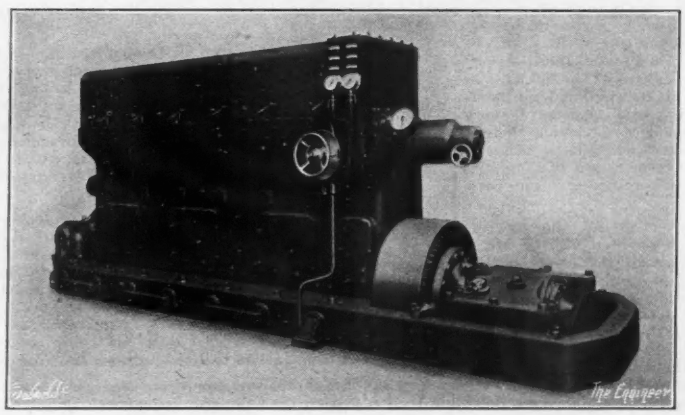


FIG. 155—330 H.P. MARINE OIL ENGINE—NATIONAL

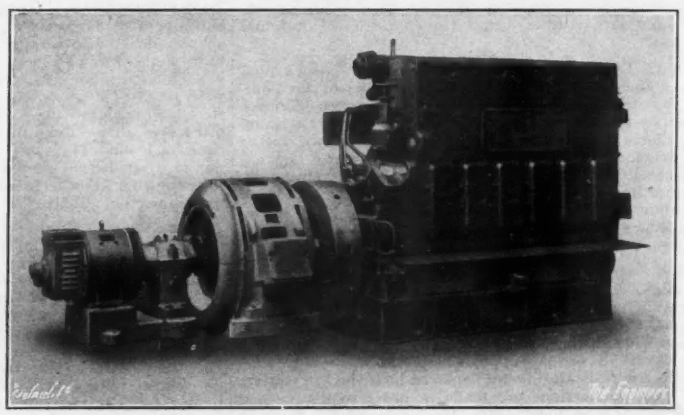


FIG. 156—225 kW. GENERATING SET—MIRRLEES, BICKERTON

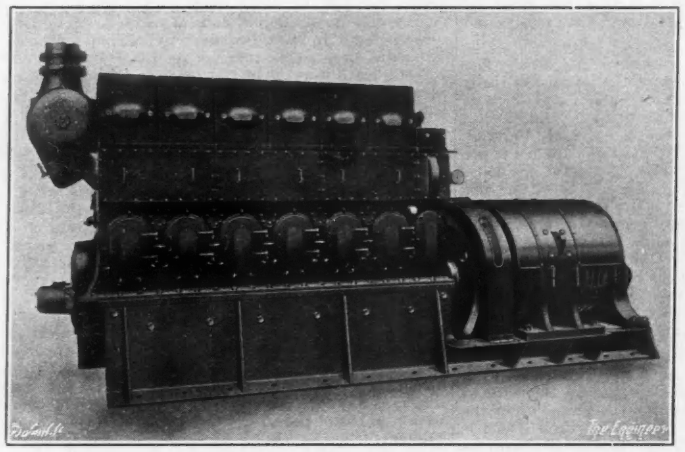


FIG. 157—MARINE AUXILIARY GENERATING SET—RUSTON

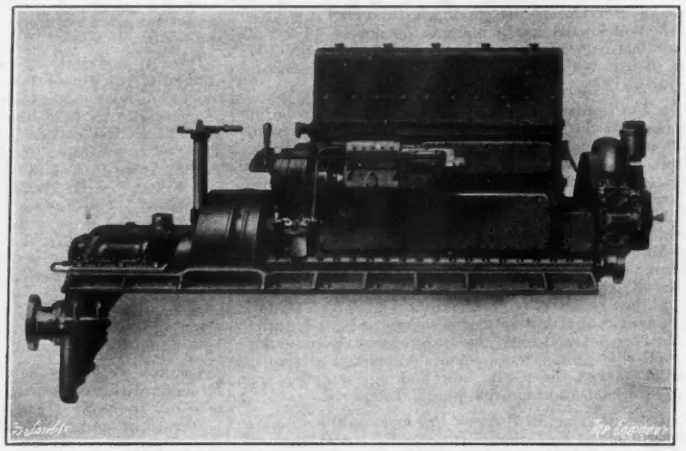


FIG. 158—120 H.P. MARINE ENGINE—RUSTON

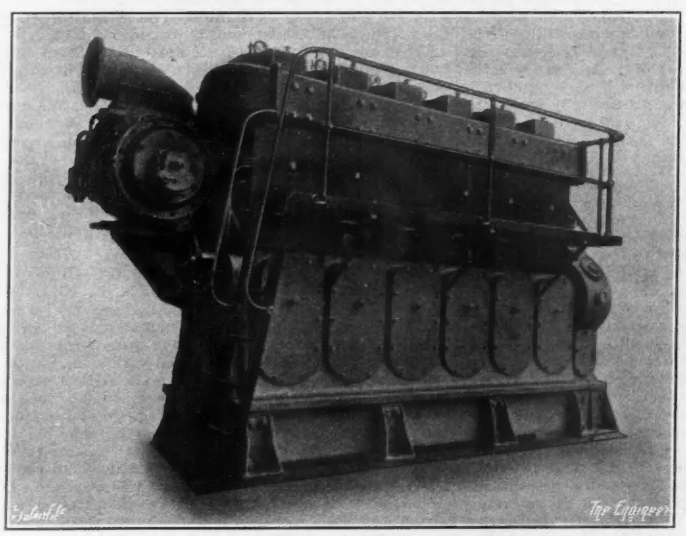


FIG. 159—1080 H.P. SUPERCHARGED OIL ENGINE—MIRRLEES, BICKERTON

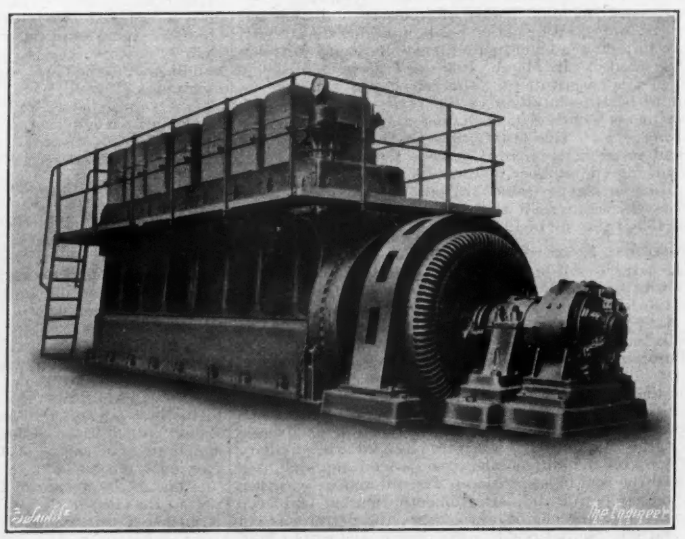


FIG. 160—875 H.P. GENERATING SET—ENGLISH ELECTRIC

The Engineer

OCTOBER 27, 1939

Vol. CLXVIII No. 4379

Contents

THE ENGINEER October 27th, 1939 PAGE

A SEVEN-DAY JOURNAL ... 413

LEADING ARTICLES—
- Fighter versus Bomber ... 425
- War and the Inventor ... 425

SPECIAL ARTICLES—
- Harbours of South Africa. (Illus.) ... 416
- Projected Exhibits at Olympia. No. VII. (Illus.) ... 427
- Scottish Locomotive Experiences. No. VI. (Illus.) ... 414
- Electrification of Darwen Paper Mills. (Illus.) ... 420
- Improved Twist Drill Grinder. (Illus.) ... 422
- Priority of Supplies ... 433
- R. H. Thurston Centenary ... 419
- Russian Munitions Production ... 421
- "The Model Engineer" ... 422

LETTERS TO THE EDITOR—
- The Sliding of Metals ... 426
- Canal Transport in War Time ... 426

LITERATURE ... 420

OBITUARY—
- Oscar Harmer ... 426
- Sir William Pope ... 426

NEWS AND NOTES—
- Air and Water ... 423
- British Patent Specifications. (Illus.) ... 435
- Catalogues ... 436
- Forthcoming Engagements ... 436
- French Engineering Notes ... 435
- Markets, Notes and News ... 434
- Miscellanea ... 423
- Personal and Business Announcements ... 436
- Rail and Road ... 423
- Sixty Years Ago ... 422

Sixteen-Page Supplement—"The Metallurgist"

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FIGHTER *versus* BOMBER

That fighter aircraft must have an adequate margin of speed over any bombers they may seek to attack is an obvious requirement, but with the rapid changes in design and with growing engine power, the balance between the two types must inevitably vary from time to time. Hence the question is often raised whether the margin to-day is as satisfactory as it was in earlier years. Unless the fighter has a good margin in speed over its huge opponent, interception is bound to be slow and the power of defence in the air correspondingly suffers. It so happens that an enterprising contemporary — a much read aeronautical journal — published a few months ago a carefully compiled set of curves showing how the speeds of the two groups had gradually varied during the last twenty-two years, that is, since 1917. During that period the speeds of both have, of course, risen vastly, in a ratio in fact of scarcely less than three to one. The curves were most revealing as to fact and reassuring as to consequence.

They showed that in the year 1918 the famous Handley Page "0·400" type, with a top speed of under 100 m.p.h., had to compete with the Sopwith "Snipe," some 25 m.p.h. faster, so that if both were at the same height and say 6 miles apart, the fighter could have caught the bomber within a quarter of an hour. Eleven years later we find that the Bristol "Bulldog" had a margin of speed over its contemporary, the Boulton and Paul "Sidestrand," of over 40 m.p.h., and so could cover the 6 miles between them in no more than nine minutes. Ten years later, bringing us almost to the present date, the contrasting types had become the Supermarine "Spitfire" and the Handley Page "Hampden," whose top speeds differ by nearly 100 miles an hour; so that the time to cover a 6 mile separation has come down to less than four minutes. It will be seen, therefore, that the position of the defence has steadily improved. The air distance flown in each case, by the fighter before it succeeds in making contact is of great interest, since it shows the extent of the aerial battlefield that would be covered in such a fight. In the 1918 case the distance covered by the fighter during the chase would have been some 30 miles, in 1929 that distance would have been 24 miles, and in 1939 about 23 miles—showing little change in battlefield size over the greater part of the period. It appears, therefore, that over this range of years—long in the brief life of aviation—the margin in speed which the fighter has had over the large bomber, whilst leaving almost untouched the size of the area of combat, has been such as substantially to reduce the time taken to intercept. During the course of the years it must happen that individual design staffs engaged on the planning of new aircraft will produce sudden increases of performance which, for the moment, may make the bomber catch up to the fighter, or the fighter to surpass the bomber by an unusually large amount. But such periods are necessarily brief, though we recollect the surprise when, some ten years ago, the then newly-produced Fairey "Fox" light bomber out-distanced at the moment of its appearance all the fighters of its day.

We have spoken so far of British aircraft alone, but as the performance figures cited represent the best that could be obtained on the technical knowledge and designing skill available at the time, and as these in turn depend on the contemporary state of aeronautical science, itself largely international in character, it is not to be expected that any materially different results would have been obtained even if all the leading industrial countries in the world had been brought into the comparison. It is, therefore, satisfactory to know that the contemporary defending aircraft have had, and still have, a comfortable margin of speed over those engaged on offensive duties. Apart from the records of the past, and what can be fairly deduced from them, there is the general consideration that on theoretical grounds one can see why the fighter should always have a better performance than a contemporary bomber. Obviously, the same engines are available at the same time for either, but whereas the bomber must have storage space for extra tankage as well as for its bomb load and larger crew, leading to increase in the cubic capacity and in the "wetted area," the fighter is not thus circumscribed and can be designed much more cleanly and efficiently. The events of the last twenty years bear out this line of argument, and there is every reason to expect that those of the next twenty will do the same.

War and the Inventor

Events which stir people deeply are frequently the cause of a spate of inventions. Thus, if a ship is lost at sea with the sacrifice of many lives, the Patent Office receives more than the average number of inventions for life-boats, davits, rafts, and other safety gear; or if there be an accident on a railway, all sorts of propositions for preventing its recurrence are sent to the railway company concerned. Sometimes the activating emotion is of a different kind. A new material, let us say, is discovered, and immediately inventors get busy devising new methods of employing it, or new uses for it. Or, perchance, a fashion, in steel furniture for example, is started, and hundreds of inventors hasten to secure by patent their right to a particular means of employing it, or to a particular commodity embodying it. The Annual Report of the Comptroller of Patents shows that waves of invention are the rule, and that each year, or longer period, is marked by the submission of specifications all connected more or less directly with the same things.

Inventions for war materials are always going on, but in times of peace most of them are made and protected by the firms in the business, some of the big armament companies at home and abroad taking out hundreds of patents each every year. A large proportion of these may be described as drawing office inventions. They are made by the draughtsmen whilst engaged in the design of parts or items. More often than not they are of little importance or significance, but, nevertheless, they are protected for a while at least until their value can be tested. Other inventions arise as the direct result of observations made by members of the firm or by officials and officers in the services, and a small number, relatively, received from quite independent people are found worthy of consideration. When war breaks out two things happen. In the first place the monopoly of patents is suspended as far as Crown orders are concerned. The Crown may have anything made anywhere by anyone, regardless of the patentee's monopoly. That does not mean that the patentee is robbed of his right, but only that he is obliged to grant a licence to whomsoever the Crown may direct. As is well known, patentees made fortunes in this way in the Great War. The second thing that happens is that all sorts and kinds of people set about inventing, some purely from patriotic motives, but most with the hope of gain. Between 1914 and 1918 a Munitions Inventions Department was set up to deal with the vast number of inventions and crude ideas submitted, and for years after the war a committee was engaged settling the amount of awards to people whose inventions had been adopted. It is a fact worth noting that the most outstanding inventions made during the war and to meet specific war purposes were British. The tank, as it was called then to conceal its real nature, and as it is still called, made a vast sensation when it appeared on the Western Front, and in the years that have passed since then it has developed in such a remarkable manner that special guns for attacking it, and special means for preventing its progress have been devised. Another notable invention in a different field was the paravane for the sweeping of mine-fields and the protection of ships; whilst two others hardly less important were the Stokes gun—or trench mortar—and the Mills hand-grenade. The German contributions to war material were poison gas and the flame projector, both, particularly the former, devices which other nations would not have been proud to originate. Mr. Hitler has already hinted at the use in the present conflict of some other invention which, if it exists at all, we may suspect, from his own words, is also of a kind that defies even the loose humanity of war.

It is an oft debated point whether or not inventors should be allowed to make huge fortunes, as a few did a score of years ago, out of war material of any kind. A great many people feel distaste if not disgust when someone demands payment for services rendered to his nation in times of the gravest stress. A contrast is drawn between the many hundreds of thousands who give their lives, and the many hundreds of thousands who lose all their worldly possessions, and even their hopes for the future, and the individual who is enriched at the country's expense. But though it is difficult to avoid some indignation we must not let it upset our sense of proportion and perspective. The inventor of the paravane made a handsome fortune out of it, but by comparison with what the paravane saved the country, ten times the amount he received would have been completely negligible. The tank was no single person's invention, and no one made directly a fortune out of it, but had someone been paid a hundred thousand pounds for it the cost would not be worth considering even though the war had been decreased by but a single day. That is one aspect of the problem. Another is a psychological one. We cannot close our eyes to the fact that the hope of reward is a stimulus to exertion, and that even when one's country's needs may be predominant in the mind, our efforts will be increased by the prospect of personal gain. It is not much use arguing about this human weakness; we know it exists and it is better to turn it to a useful end than to endeavour to suppress it. In other words, it is better to encourage invention even if the country has to pay than to discourage it by saying that the inventor shall not be rewarded. We all hope and pray that this war may not

continue long enough for many new inventions to come to light and bear the test of trial on the field of battle. But we trust, nevertheless, that no means of employing the inventive talent of the British people will be lost, and that the question of reward will be wisely considered. It should not be excessive, but it should be adequate. As the profits of manufacturers and retailers are limited so might be the fortunes of inventors, always remembering that the labourer is not less worthy of his hire because his services are of national value.

Obituary

OSCAR HARMER

AN APPRECIATION BY SIR ALFRED HERBERT

AFTER a long illness, my old friend, Oscar Harmer, has passed peacefully away in his ninetieth year.

For some time past he had felt the growing burden of his age and he had gradually relinquished more and more of the active work which he had carried on for so long, though up to a few months ago he was invariably in his office chair in the morning before any of us appeared.

When he was first introduced to me by our mutual friend, the late Charles Churchill, he was managing the Capewell Horse-nail Company's Works at Millwall. I spent a happy day with him there and I was much impressed by the efficiency of the organisation and by the ingenuity of the automatic machinery which produced finished nails from coils of wire.

We were both full of enthusiasm about machine tools and engineering generally, and we were drawn together by our common interests which formed the basis of an enduring friendship.

Harmer subsequently joined the Babcock and Wilcox Company (then at Kilbowie) and was largely responsible for the design and equipment of their new works at Renfrew. I remember staying with him in Scotland at that time, and very vividly do I recall our breakfasts before daylight and our early journeys to the works amid the rigours of a Scottish winter.

In 1897 I invited Harmer to join me at Coventry, and he subsequently became a Director of the Company. One of his first undertakings for us was the building of a new foundry at Edgwick, about three miles from our original headquarters. This foundry is still in active operation, and was in fact the nucleus of the present Edgwick Works, where the whole of our plant is now concentrated.

It was through Harmer's introduction that the late P. V. Vernon came to me at Coventry, first as a draughtsman and subsequently as Chief Designer and a Director of the Company. Vernon was a man of exceptional ability and initiative, and his untimely death was a great loss to us, but his memory is perpetuated in many of our machines, which still bear evidence of his skill and original thought.

Harmer was a man of altogether unusual qualities and of unbounded energy. It was never too early for him to start work and never too late to finish. He was a born mechanic with a great sense of fine workmanship; the best was good enough for him, but only just. He was a merciless critic of everything that fell short of his own exacting standards. He was intensely practical, and I remember seeing him with his coat off in the smithy forging a lathe tool to exactly the shape that he wanted, while the smith looked on dumbfounded. He permeated the whole place: drawing office, works, and commercial offices alike, and he left his mark on everything he touched.

As a salesman he had few equals. In the early days he was our best traveller; doing his journeys often at night and his work during the day. His happy personality, combined with his practical knowledge of his job, ensured him a welcome and a hearing wherever he went. He had the strongest conviction that fine machine tools could never be cheap, and that the true measure of a machine was what it would accomplish and not what it cost.

He was an excellent mixer with all sorts and conditions of men, from the highest official to the youngest apprentice, and was equally frank and friendly with both. His memory was wonderful, and he was a vivid and amusing raconteur of experiences and adventures during a long and busy life.

With unbounded generosity and friendliness, he never turned a deaf ear to those who came to him in trouble. To me he was a great friend as well as a most valued helper, and I think there was nothing in his power that he would not have done for me at any time.

To everyone connected with the Works he was an inspiration, and among our workpeople he was looked on with affection and respect. He was a man of picturesque language, but his criticisms, however drastic, were both given and taken in good part. He was a genial host and knew how to order a dinner. He was greatly interested in sport and possessed in a unique degree the happy ability of rejoicing in the enjoyment of younger folk.

He will be greatly missed by the world-wide circle of friends which he had built up in a long and strenuous life. There are, in fact, few users of machine tools in the world to whom his name and work are not familiar. May he rest in peace.

SIR WILLIAM POPE

WE regret to record the death, at Cambridge on October 17th at the age of sixty-nine, of Sir William Pope, K.B.E., F.R.S., Professor of Chemistry at Cambridge University for the past thirty-one years. By his death, the University and the chemical industry are deprived of the services of a great scientist and national benefactor.

During the late war his work was of the greatest benefit to the nation. Sir William, who became a member of Lord Fisher's Admiralty Inventions Board, was consulted by several Government departments. In 1914 the chemical industry was largely centred abroad, and therefore new methods of making vital war materials had to be rapidly developed. As examples of this work, Sir William Pope and his colleagues not only enabled adequate supplies of aerial photographic plates and mustard gas to be made, but also improved on the German methods. The ordinary photographic plate is insensitive to all light except blue, and for aerial photography it is essential that panchromatic plates, responding to yellow, green, and red be used. Up to that time such plates were sensitised with rare dyes, of which the production had never been undertaken outside Germany. The result of Pope's work in this connection was that sensitive materials were found which were more effective than the German products.

When the Germans started to use mustard gas, another problem had to be solved. If chemical warfare was to be used effectively by the Allies, this gas was essential in quantities. Pope devised a method of manufacture cheaper and less complicated than that used by the Germans, with the result that, towards the end of the war, the Allies' production was thirty times that of their enemies. At the end of the war, Sir William was made a K.B.E.

William Jackson Pope was born on March 31st, 1870, in London, where his father was in business. He went to Cowper Street Endowed Schools, in Finsbury, and, when the Finsbury Technical College was established by the City and Guilds Institute, he entered the chemical department of the college as one of the earliest students of Professor Armstrong. In 1887 he went with Armstrong to the Central Institution, now known as the City and Guilds College of the Imperial College of Science and Technology. In 1901 Pope was appointed Professor of Chemistry and Head of the Chemistry Department at the Municipal School of Technology; later, in 1905, he was Professor of Chemistry to the Manchester University. In 1908 Pope was appointed to the Chair of Chemistry at Cambridge, in succession to the veteran Professor Liveing, and he remained there until his death took place.

He obtained many distinctions and belonged to many learned societies. Pope was awarded the Longstaff Medal of the Chemical Society in 1903, the Davy Medal of the Royal Society in 1914, and the Dumas Medal of the Société de Chimie Industrielle in 1921. The Society of Chemical Industry awarded him the Messel Medal in 1932. He held office as president of several societies, acted as chairman of numerous committees and conferences, and published many papers in connection with his work. He was known as a chemical research worker of genius, and in 1922 received the highest possible honour by being elected as president of the International Union for Pure and Applied Chemistry.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE SLIDING OF METALS

SIR,—The most interesting paper on the sliding of metals, by F. P. Bowden, L. Leben, and D. Tabor, in the August 25th, 1939, issue of THE ENGINEER raises some questions possibly worth considering. The authors seem to have established that what may appear as continuous sliding between two surfaces is actually a series of "sticks" and "slips." The following questions are in no wise intended as a criticism of the authors' work but rather as requests for information which perhaps others too might like to have.

To a comparative layman like myself it is not clear that the three types of sliding are distinct, except as the characteristics are functions of the shapes of the slider and the base plate (curved slider, flat base plate). The distinction made between sliding of Type 1 and sliding of Type 2 is that in the case of Type 2 the slips are larger, and blobs of the slider are wiped on to the base plate. Presumably in sliding of both types the magnitude of the slips would vary widely with different materials, so that it seems questionable whether the larger slips reported for Type 2 are in fact characteristic. And are the blobs characteristic? If steel had been slid on molybdenum, for example, might not small blobs of steel have been wiped off on the molybdenum? Or if steel had been slid on bearing metal, might there not have been an absence of blobs? Or again, may there not always be blobs present in any case, of microscopic dimensions, for some combinations of metals? When the melting point of the slider is lower than that of the base plate and blobs of metal are wiped off, the curvature of the slider changes. What is the effect of this change, if any, other than to increase the area or the apparent area of contact?

Did the force used to pull the slider act in the plane of the contact surface of the base plate? If not, there would be a tendency to rock the slider, with a possible effect on the results.

It would seem important to eliminate or to study the effect of the differences in shape of the slider and the base plate by reversing the two, that is, by testing a curved bearing-metal slider on a flat steel base plate and also a curved steel slider on a flat bearing-metal base plate, etc. Could this variable be eliminated by using flat surfaces for both slider and base plate?

Do not the stick-slip fluctuations found in lubricated conditions actually indicate the absence of sufficient lubricant? This is implied where the authors state in speaking of a piston sliding in a cylinder that "in general the extent of the slip becomes smaller as the sliding speed increases." At higher sliding speeds lubricant is more effectively wiped in between the surfaces of contact, and the more pronounced jerks found at lower speeds would seem to indicate that lubricant is partially squeezed out.

WM. R. OSGOOD,
Materials Engineer,
Engineering Mechanics Section.
National Bureau of Standards,
Washington, D. C.,

CANAL TRANSPORT IN WAR TIME

SIR,—In reference to your paragraph under this heading, while it is not yet possible for anyone to forecast the duration of the present conditions, if the conservation of imported fuel becomes a vital necessity, there is surely scope here for experimenting with producer gas sets. The gas-driven barge and tug is well established on the rivers of Europe, and in the case of the British "narrow" canal barge with its 25 H.P. engine, the producer set would occupy but little extra space, and if the engine was a "flat twin" it could be placed over it. A fuel problem hardly exists because in place of depending for oil on one or two fuelling stations, a few bags of coal could be taken on board at any lock.

Naturally any worth-while developments on these lines would depend upon conditions in the liquid fuel market, but as an alternative to the producer gas set, there is that of a high-speed steam engine and a boiler. Here again neither a water or fuel problem exist like they do with road vehicles.

While I myself am not professionally acquainted with mechanical transport on canals, I have acquired quite a considerable knowledge of it by operating my own small craft on the rivers and canals of this country for some twenty years and as an engineer, while admitting that neither the gas or steam plant would show the economy of the oil engine, it might be a case of "needs must when the Devil drives."

JOHN D. WATSON.

Projected Exhibits at Olympia

No. VII

(*Continued from page 407, Oct. 20th*)

BELOW we continue our description of some of the exhibits which were to have been shown at the Engineering and Marine Exhibition at Olympia, London, the holding of which has had to be postponed on account of the war.

E. N. MASON AND SONS, LTD.

Most drafting machines on the market are of German manufacture, and, of course, at the present time are unobtainable. Therefore a new range of such machines, made by E. N. Mason and Sons, Ltd., which would have been shown on the firm's stand at the Exhibition is of particular interest. In Fig. 161 is illustrated a vertical weight-compensated model, in the design of which there are incorporated no fewer than ten ball bearings, so as to give smooth operation and lightness of touch. For a horizontal drawing board a simpler arrangement, without counterbalance weights, is used, and six ball bearings suffice for the same degree of smoothness.

Known as the "Arclight" drafting machine, it is claimed to be swift and convenient in use.

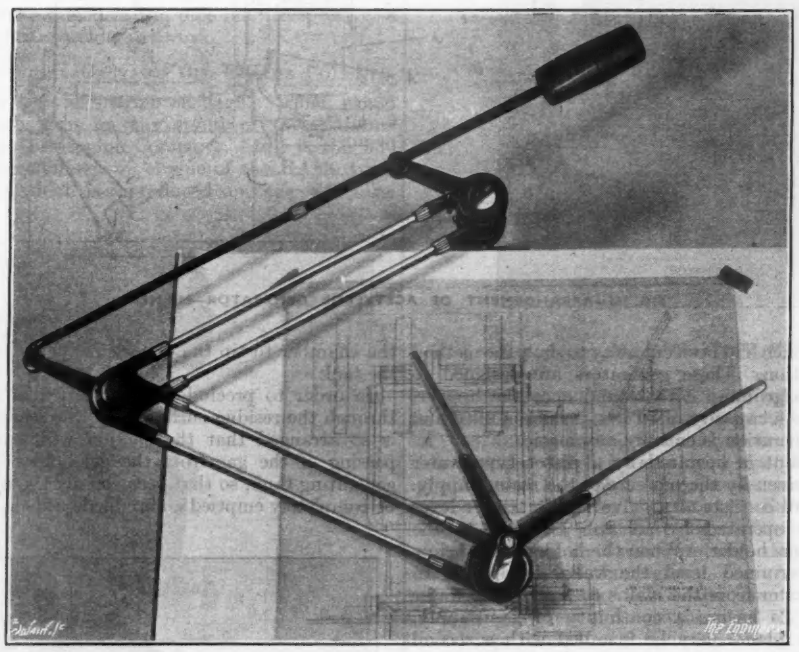


FIG. 161—COUNTERBALANCED DRAFTING MACHINE—MASON

Its design follows the band type of construction—a method of obtaining parallelism which, we are informed, ensures that complete accuracy is obtained over the whole drawing board surface. The workhead elbow and mounting contain precision machined pulleys round which run strong high tensile steel bands. These bands are tightened by turning the arm tubes, and give the necessary rigidity at the scales. The whole mechanism is enclosed as far as possible, and the top of the workhead presents a natural and pleasing hand grip, while the underneath surface is clean, smooth, and discourages the collection of rubber dust and other foreign matter.

Every 5 deg. angle from 0 deg. to 180 deg. in both directions can be automatically selected. This selection is effected by a mechanism in the workhead which, instead of employing one selector dog dropping into one segment, has a five-tooth selector block dropping into the five teeth of an accurately made protractor plate at each 5 deg. setting. The workhead mechanism is mounted on two ball bearings, and has a centre-spindle 7/16in. in diameter. The device is controlled by a thumb-button which directly releases the 5 deg. selector dogs, and a wheel within the thumb-button provides a lock for angularities other than five deg. A magnifying glass is placed in the workhead cap, directly over the 360 deg. protractor and its vernier. Scale fixing has been simplified, by providing fixing plates 4½in. long attached to each scale, giving rigidity without the need for locking wheels which may graze the fingers. When the scale is in the working position, the fixing plate and its screws are concealed; partial withdrawal of the scale from the scale arm exposes the screws for scale setting.

Made of aluminium alloy, the scales are single-sided, and tapered so as to be light and obscure the board as little as possible. Nevertheless, they are surprisingly stiff and are claimed to be considerably stiffer than wooden scales of three or four times their cross section. Furthermore, the "satin anodic" finish and clear engraving adopted makes it easy for them to be read, and shrinking and warping cannot occur.

An arrangement for setting the machine to a drawing or to an odd angle base-line is provided in the elbow, and controlled by a knob on the top of the elbow. By releasing this elbow lock the workhead can be swung so that zero is represented by any angle in the circle. The protractor reading and zero marks on the two scales are placed close in relation to each other, making for easy visual control of the machine with the minimum of eye movement.

The weight of the whole machine is borne by a heavy tapered pin mounting, which is set at an angle of 45 deg. from the vertical. When placed in position, the machine is claimed to be free from shake and play, but at the same time, it can be readily lifted from the board, or folded up and swung over the back of the board, leaving the whole working surface free.

In Fig. 162 we illustrate the firm's "New Century" duplex double elephant continuous photo-copying machine, which would also have been shown. In this machine the light distribution over the entire printing plane is claimed to be perfect, and infinite speed variation can be obtained between upper and lower limits. The actual printing speeds are at all times electrically recorded. Furthermore, it is claimed to be the first completely independent duplex copier, inasmuch as the travel of the arc lamps is effected by an entirely separate mechanism, self-contained and provided with its own electric motor. By this means, the speed of travel of the arc lamps can be maintained, irrespective of printing speed, so that uniform printing on both sides of the machine is obtained.

In order to make the machine suitable for the fine graduations necessary when using pencil tracings on detail paper and the new positive printing processes, the power and variable-speed unit (Fig. 163) is arranged to incorporate a four-speed gear-box, with simple gear-changing means.

In twin-lamp models, in the lamp travel mechanism the trolley supporting the two arc lamps carries also the mechanism controlling the reciprocating movement. The power is provided by a 1/20 H.P. motor, and is transmitted through worm gearing to a crank operating in a specially designed cross-head fixed to the top frame of the machine. The shape of this cross-head provides for a dwell at each end of the stroke, practically equal in duration to the time taken for the lamps to travel across the machine. We are informed

FIG. 162—DUPLEX PHOTO-COPIER—MASON

that this dwell is necessary to ensure complete exposure of the extreme edges of the prints when utilising the full width of the machine.

The objection in the past to twin lamp machines has been the difficulty of exactly balancing the two separate lamps, but, the makers claim, this difficulty has been overcome in the present design

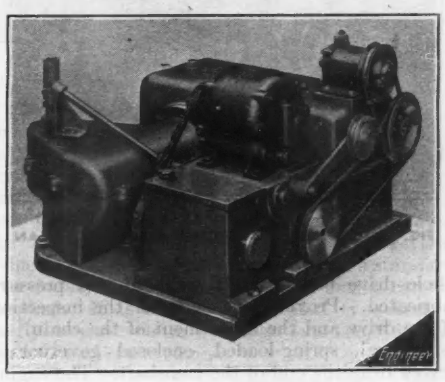


FIG. 163—POWER UNIT OF COPIER—MASON

by providing two balancing regulators in all twin-lamp "New Century" machines.

DAVEY, PAXMAN AND CO. (COLCHESTER), LTD.

The oil engines manufactured by Davey, Paxman and Co. (Colchester), Ltd., which would have been shown at the Exhibition, comprise a range suitable for direct propulsion, oil-electric, and auxiliary sets for marine use, for stationary purposes and for industrial purposes. They are all of the Paxman-Ricardo type, employing the Ricardo "Comet" Mark III combustion chamber, which is claimed to give complete and efficient combustion, easy-starting properties, flexibility over the speed range, and the ability to develop considerable overloads when necessary.

In the accompanying engraving (Fig. 164) is shown the firm's "6RX" six-cylinder oil engine, seen from the governor control end. The over-speed governor and other special fittings are not standard on these engines, nor is the position of the flywheel, which is usually mounted on the driving end of the crankshaft, under the governor control wheel. The engine illustrated is rated at 336/370 B.H.P. at 600 r.p.m., and the cylinder bores and piston strokes are 9½in. and 12in. respectively; it is also rated at 425/465 B.H.P. at 750 r.p.m.

Following the firm's standard practice, the main construction is of cast iron, consisting of a deep bed-plate, carrying the main bearings and separate "A" frames which support the cylinder block. High-tensile bolts pass right through the frames, and are tightened in assembly to a degree greater than the tension which can be imposed on them by

the combustion loads. As a result of the frames being always in compression, great rigidity is claimed to be obtained, and the inspection doors can therefore be made large without weakening the design. The framework is arranged to permit the removal of the pistons and connecting rods complete without disturbing the cylinder heads or other parts of the engine.

The working components of the engine follow the firm's practice; for example, the crankshaft is machined all over, separate iron liners are fitted, and the gudgeon pins are of case-hardened steel, ground all over and arranged to be fully floating. The small end bearing bush is carried in a solid eye of the connecting rod, thus avoiding the use of bolts, and is lubricated from the main system. The cylinder heads are provided with valve inserts with non-pitting seatings, and the working faces of the valves are stellited. The valves are operated by push-rods and hardened rockers, bearing on case-hardened and ground cams on the camshaft. Full pressure lubrication is provided for all parts of the valve gear. Starting valves are fitted to each cylinder and on opening the master control are automatically operated in the correct sequence by means of an air distributor.

Arranged at the driving end of the engine, that is to say the end at which the flywheel is normally fitted, the camshaft drive is by roller chain, the

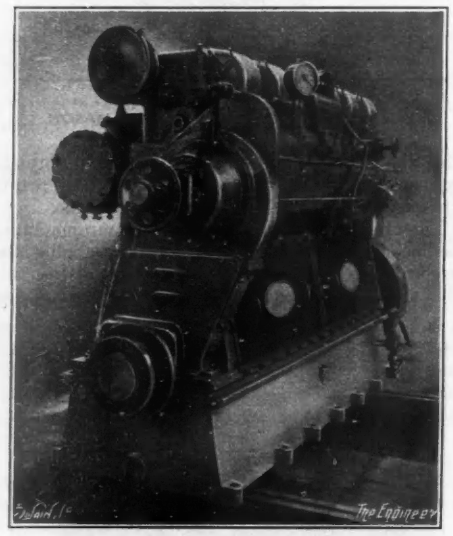


FIG. 164—336 H.P. OIL ENGINE—DAVEY, PAXMAN

whole drive being totally enclosed and pressure lubricated. Provision is made for the inspection of the drive and the adjustment of the chain. A centrifugal, spring-loaded, enclosed governor is driven from the end of the camshaft. The engine speed can be adjusted by means of the handwheel, shown in the engraving, while the engine is running.

The "RX" series of engines is built with any number of cylinders from four to eight, in a range of powers from 224 B.H.P. to 450 B.H.P. at 600 r.p.m., and 288 B.H.P. to 560 B.H.P. at 750 r.p.m. At these speeds they can be continuously run at full load or for one hour at 10 per cent. overload, according to the makers; higher speeds up to 900 r.p.m. can also be obtained. Modified, the engines are suitable for marine use, and they are also made with a long stroke of 17in. in units of three, four, six, eight, and ten cylinders, with powers ranging from 180 B.H.P. to 600 B.H.P. at the normal speed of 450 r.p.m. Engines of this type can be run, with corresponding alterations in output, at speeds of 375, 428, and 500 r.p.m. for use with 50-cycle alternators.

In Fig. 154, on page 424, is shown an eight-cylinder Paxman-Ricardo "Vee RB" oil engine, coupled to a generator and provided with a radiator. Engines of this type have been supplied by the firm for installation in trailers for portable emergency use. An engine such as shown in the photograph reproduced would have been on view on the firm's stand at the Exhibition. It is rated at 400 B.H.P. at 1500 r.p.m. and has cylinder bores and piston strokes of 7in. and 7¾in. respectively. Engines of this vee-form are made with eight, twelve, and sixteen cylinders, with outputs of 400, 600, and 800 B.H.P. at 1500 r.p.m. Cast-iron construction is adopted for commercial, traction, industrial, and marine purposes, and light alloy construction for high-speed marine craft, railcars, and other purposes.

A full description of a sixteen-cylinder engine of this type, suitable for marine use, was given in The Engineer of July 22nd, 1938.

C. S. Milne and Co., Ltd.

Among the exhibits of C. S. Milne and Co., Ltd., there was to have been included one of the company's "C" type carbide to water, automatic feeding and de-sludging, acetylene generators, part of which had been cut away to show the method of operation. These generators are designed to handle large lump carbide and once the hopper, which has a capacity of 10 cwt., has been filled and sealed, operation is entirely automatic.

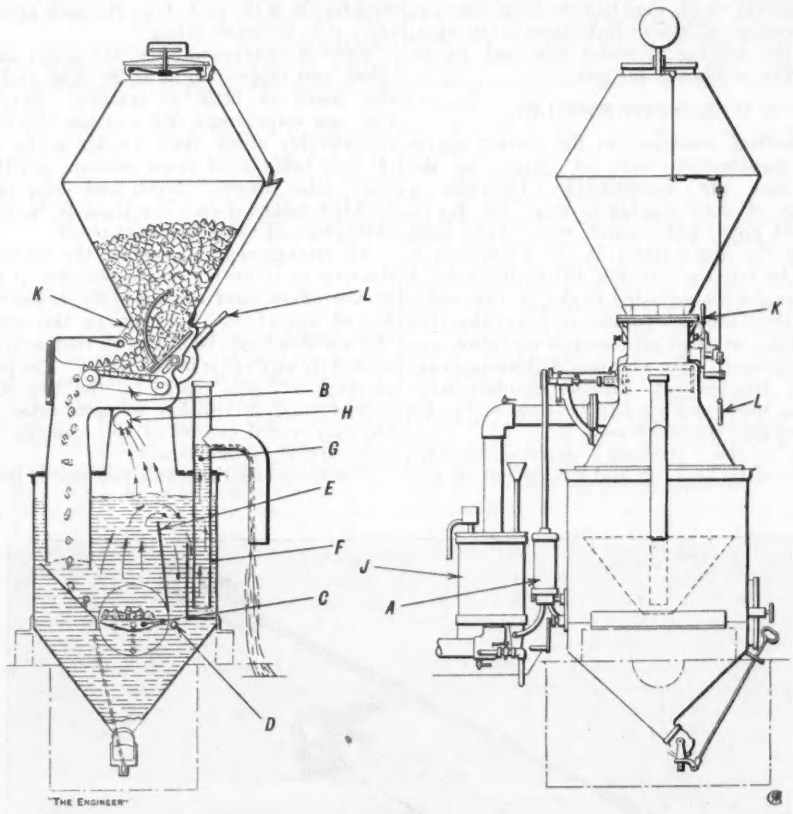


FIG. 165—ARRANGEMENT OF ACETYLENE GENERATOR—MILNE

The plant is operated by a piston-type water engine driven by the pressure of the mains supply. Its control consists of a valve with a trigger lever which is operated by an arm attached to the floating gas holder. When the holder sinks below a predetermined level the valve is opened to permit water from the mains to flow to the water engine. To ensure a continuity of gas supply, duplicate plants may be installed with a second selector valve which automatically cuts out one generator, when the carbide is exhausted, and starts the other.

Operation of the generator can best be followed by reference to the drawings (Fig. 165). After passing the control valve the water drives the engine A which, through a pawl and ratchet gear, rotates a chain belt conveyor B to feed carbide from the hopper on to a grid C in the generating tank. The movement of the chain belt agitates the sealing door at the hopper base and prevents the carbide from bridging. The feed of carbide is regulated by a cam quadrant device, behind the ratchet wheel, which sets the effective stroke of the water engine.

Exhaust water from the engine flows into the generator through the pipe D which is so directed that the stream of cool water attacks the carbide as it is distributed on the grid. By this means carbide and water are introduced into the chamber in measured proportions ensuring cool and consequently pure acetylene being generated.

The inflow of water, the rising bubbles of acetylene and the heat of generation, all combine to assist circulation of the water. A division baffle plate E encourages this circulation to follow the most advantageous path upwards through the grid and downwards past the residue evacuation chamber F, so that a stirring action takes place and the lime residue is carried over the baffle plate into the chamber F. From the evacuation chamber the lime is ejected through the outflow pipe G. This arrangement prevents the possibility of the evacuation of live carbide. The evacuation chamber has a further advantage in that, in the event of an unprecedented rise in pressure from any cause, the water seal in the pipe G will be broken and acetylene will be exhausted into the atmosphere without lowering the water in the tank to a level at which dangerous overheating can take place. Heavy metallic substances and coke in the carbide which are too heavy to be carried away by the flowing water are deposited on the grid. In order to prevent their accumulation the grid is mounted on a spindle and can be turned from the outside of the chamber to tip the deposit into the bottom of the tank.

In order to preclude further any inflow of air through the residue outflow pipe, the seal chamber is so arranged that the suction will cause by-passing of the gas from the gas-holder into the generating tank, so that occasionally the plant can be completely emptied and refilled with clean water

FIG. 166—ACETYLENE GAS GENERATOR—MILNE

without any introduction of air or loss of gas, since, on refilling the tank, the gas is once more forced into the bell.

The rising gas passes out of the generating chamber through the pipe H and on to the seal chamber J.

The plant incorporates a number of safeguards to ensure correct manipulation during charging. An

interference cover is hinged over the charging door of the carbide hopper. This cover cannot be lifted until the handle K is thrown over to shut the feed space on to the carbide feed conveyor. The handle, through a system of levers, disconnects the drive between the water engine and the conveyor so that, in the event of the gas-holder falling during charging, the conveyor is not moved if the water is turned on. A rod from the handle K interlocks with the handle L of an airtight sealing cover at the base of the carbide hopper. This handle also controls the movement of the interference cover over the hopper charging door. It will therefore be seen that until the hopper is sealed and the interference cover is replaced carbide cannot pass out on to the conveyor, the conveyor cannot be put in motion, and an effective seal is provided to prevent the intermingling of gas and air in the conveyor chamber. The sealing also ensures that no carbide dust of the new charge comes into contact with damp or water in an atmosphere of acetylene and air. The plant shown in Fig. 166 also includes a purification chamber in which any small percentages of sulphur and phosphorus in the gas are removed.

To work in conjunction with these generator plants the company has developed a system of distributing the gas by pipe-line, to the welding stations in a works, at a constant pressure up to 22 lb. per square inch. The gas is fed by a high-speed rotary compressor to the pipe-lines and any excess is by-passed back to the inlet side of the compressor. In this manner a constant pressure level is maintained in the pipe-line irrespective of the number of welders at work.

The National Gas and Oil Engine Co., Ltd.

A new type of marine oil engine, which would have been seen on the stand of the National Gas and Oil Engine Company, Ltd., is the 330 B.H.P. six-cylinder oil engine of the HAM6 type, a view of which is reproduced on page 424. The

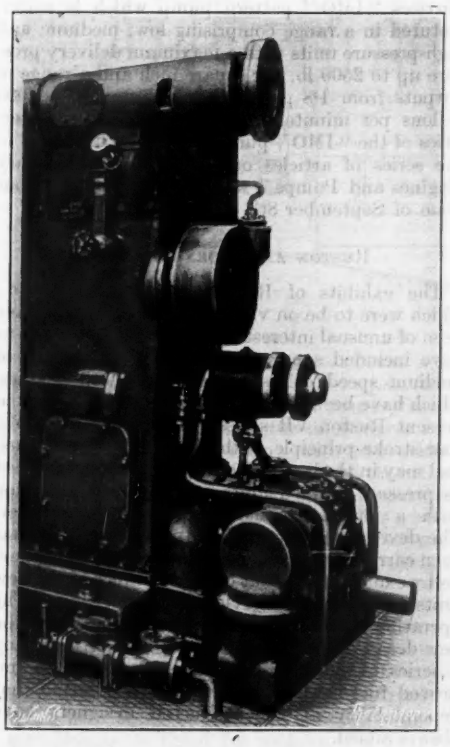


FIG. 167—FORWARD END OF OIL ENGINE—NATIONAL

engine has a bore of 10in. with a stroke of 13in., and runs at 550 r.p.m., a 2 : 1 oil-operated reverse-reduction gear giving a propeller speed of 275 r.p.m. This engine is representative of a series of six engines with outputs ranging from 165 to 440 B.H.P., with from three to eight cylinders. A series of RAM engines of generally similar type provides a range of three to six cylinder engines with designed outputs of 120 to 240 B.H.P. at 600 r.p.m., or a propeller speed of 300 r.p.m. with 2 : 1 oil-operated reverse-reduction gear. The engines are of the four-stroke type with compression ignition and airless injection of fuel, and, as our engraving shows, the design adopted is very neat as regards the centralised control and the enclosure of the principal working parts.

A one-piece design of bedplate is used which carries the main crankshaft bearings, which are water cooled. The column casting is bolted directly to the bedplate and is bored to receive the loose liners. An air manifold forms an integral part of the column casting. The crankshaft is a solid forging of Siemens-Martin acid steel, and the connecting rods are made from the same material. The crankshaft is exceptionally stiff, and its dimensions are in excess of Lloyds Register requirements, the dimensions being such that it is possible to use short cylinder centres without excessive bearing pressures. The main bearings are white metal lined, and they are round backed so that they can be removed for examination without having to lift the crankshaft.

The liners and the pistons are machined and finished to very close limits, and each part being interchangeable makes replacement very easy. The pistons are furnished with pressure and oil scraper rings, and the piston pin is of the floating pattern. The cylinder heads are made of high-grade cast iron, and the design is such that the load is transmitted on a continuous wall inside the evenly-spaced holding-down studs. The head

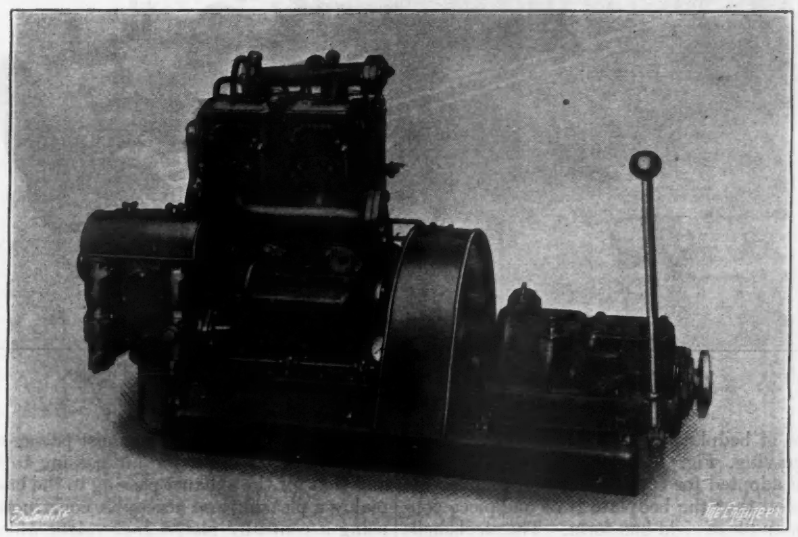


FIG. 168—18½ H.P. MARINE OIL ENGINE—NATIONAL

carries the valve guides with "stellited" inserts for the valve seats. All the valves are of the vertical type, and are arranged directly over the piston. Heat-resisting steel is employed for the valve spindles, and the valve faces, in the case of the exhaust valves, are "stellited." Each valve is furnished with double springs. The camshaft carries hardened steel cams and it is driven from the flywheel end of the engine. The whole of the valve gear is pressure lubricated from the main lubricating system. An atomiser of the spring-loaded type is used, and its design is such that the cooling water flowing through the cylinder head is brought close to the atomiser seating and flows around the body of the atomiser, with the result that it remains at a constant temperature. For straining the fuel oil a Monel metal fuel strainer, consisting of an inner and an outer gauze, is fitted to the atomiser. There are separate fuel pumps for each cylinder, each of which can be separately adjusted, while the case-hardened steel fuel cams are also adjustable, and permit the alteration of the time of injection within certain limits. At the flywheel end of the engine is the governor which has a speed control handwheel and can be adapted for either engine room or remote control schemes.

A feature of the new design is the simple arrangement of the engine control gear. The handwheel control is placed at the flywheel end of the engine, with the necessary oil and starting air gauges above it, and it is marked with the "start," "running," and "stop" positions. When the handwheel is turned to the "start" position, the fuel pumps are automatically cut out and starting air admitted to the starting valves so that the engine is run up to speed on compressed air. A half turn of the handwheel brings the controls into the "running" position, in which the fuel pumps are brought into action and the supply of compressed air cut off, a quick-closing valve being included in the compressed air line. A further quarter turn brings the control mechanism into the "stop" position, cutting off the supply and stopping the engine. It is claimed that with this simple control device, excessive cylinder pressures are prevented as there can be no injection of fuel until the compressed air has been cut off.

The end view of the engine remote from the flywheel, which we reproduce in Fig. 167, shows clearly the arrangement of the air inlet filter, the lubricating oil strainer, and the circulating and bilge pumps. All the main bearings, crank pins, and valve operating mechanism are lubricated by oil delivered under pressure at about 15 lb. per square inch. The pressure gauge is coupled to the remote end of the oil system, and the pressure in the system can be varied by a handwheel which controls the amount of lubricating oil which is by-passed. For priming the oil system before starting, a semi-rotary hand pump is provided.

As previously mentioned, the cooling water is made to pass first through the bedplate under the main bearings, and then to the columns and the cylinder heads, finally being discharged through the water-cooled exhaust pipes. Separate regulation for the amount of water which passes through each cylinder is provided. The circulating water and bilge pumps are of the reciprocating pattern, and are made in gunmetal. A change-over cock enabling either pump to be used for the duty of the other is fitted, and there is also a conveniently arranged hand clutch for cutting out the bilge pump when this is not required. There is provision for a dynamo, winch, or capstan drive at the forward end of the engine. The reverse reduction gear is generally supplied with a standard gear reduction of 2 : 1, but other ratios can be supplied. It is of the oil-operated type and is neatly housed on a bedplate extension at the flywheel end of the engine.

The smaller range of engines of the "DM" series, which we illustrate in Fig. 168, includes two to four-cylinder units with a bore of 4¼in. and a stroke of 6in. The designed outputs are 18½, 28, and 37 B.H.P. respectively, when running at a speed of 1000 r.p.m. These engines have found wide use for marine propulsion and auxiliary work in all parts of the world, and they have been shown at previous Olympia exhibitions. Points in the design include the use of detachable individual cylinder heads, and the convenient grouping of the auxiliary pumps at the front of the engine along with the starting gear. For this type of engine an epicyclic bevel wheel reverse gear is usually provided, and if desired a reduction gear giving about half engine speed in the ahead and astern directions can be included, or oil-operated gear similar to that fitted to the larger engines can be adopted—a course which has been followed, we learn, in many of the firm's most recent installations.

Mirrlees, Bickerton and Day, Ltd.

Some new designs of oil engines were to have been shown on the stand taken by Mirrlees, Bickerton and Day, Ltd. We illustrate on page 424, Fig. 159, one of the firm's latest Mark "HF6" engines which is representative of a range built in units from three to eight cylinders, embracing designed outputs from 295 B.H.P. at 333 r.p.m. to 1440 B.H.P. at 430 r.p.m. The actual engine which was to have been shown was to have had a Buchi type exhaust-gas-driven turbo-blower for supercharging, but the engine is so arranged that if preferred an engine-driven supercharger can be supplied. Supercharging is recommended in order to meet the special requirements of customers, and for engines called upon to work at high altitudes.

The engine shown in our engraving has a bore and stroke of 13¾ and 21in. respectively, with an output of 1080 B.H.P. at 430 r.p.m., and the designed brake mean effective pressure is between 70 and 75 lb. per square inch. The general construction follows closely earlier Mirrlees practice, but new features and improvements have been introduced. An enclosed engine has been produced, with forced lubrication for the principal working parts. Accessibility has been closely studied, and the cylinder heads and valve gear are readily reached for inspection by opening hinged covers which are made from a light alloy metal.

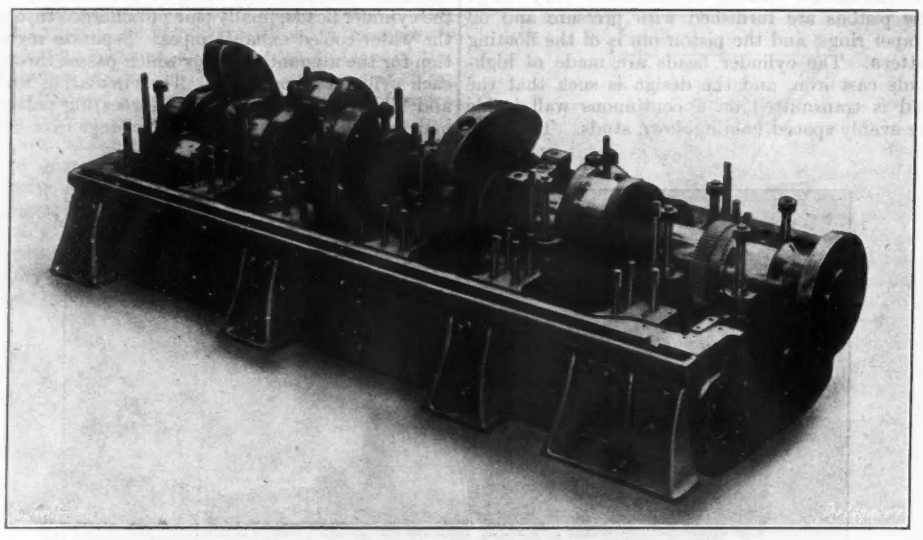


FIG. 169—FIVE-CYLINDER ENGINE BED PLATE—MIRRLEES

The type of bedplate employed will be seen from our engraving, Fig. 169, which shows the construction adopted for the five-cylinder engine. It will be seen that the bedplate is of one-piece construction and is of rigid box form. The steel shells of the main bearings are white-metal lined and are ample in length. The oil sump is cast into one end of the bedplate, and a useful provision is the groove for the collection of oil cast on the top of the bedplate, which prevents the leakage of oil to the foundations. The crankshaft is made from a 34–38 ton Siemens-Martin open-hearth steel which is heat treated, and the scantlings adopted exceed the requirements of Lloyd's Register for marine work. A large size of the crankshaft gives an

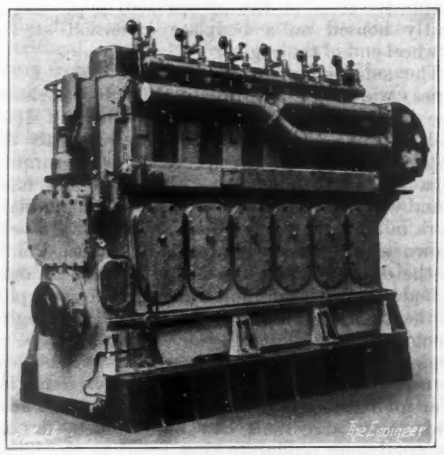


FIG. 170—REAR OF 1080 H.P. ENGINE—MIRRLEES

engine, it is claimed, which is free from serious critical speeds throughout the running range adopted. As illustrated, balance weights are fitted when required, and the half-coupling for bolting to the flywheel hub is forged integrally with the crankshaft.

The engraving we reproduce in Fig. 170 shows the back of the engine and the construction of the column and the cylinders. The column is of deep section and is made in cast iron, and the inspection doors are large and have been specially designed in order to allow a piston and connecting rod to be withdrawn from below, for the examination of the piston rings, without having recourse to breaking cylinder head joints. The column structure also houses the camshaft, which is mounted in split adjustable bearings lubricated under pressure. The camshaft drive is arranged at the flywheel end of the engine, machine-cut gears being used, and the exhaust and air valve levers are worked through tappets which carry the cam rollers.

It will be noted that the separate cylinders are bolted to the top of the column, and that they are of symmetrical design, with provision for cleaning the water spaces. All liners are made from special liner metal and are fixed at the top end, but are free to expand downwards, the water space being sealed by rubber rings. All cylinder heads—see Fig. 171—are of deep section and are secured by eight bolts. The air and exhaust passages are cast in the head, that for the air passing to the front and that for the exhaust passing to the back, which makes a pleasing and accessible construction. By using a centrally placed fuel valve, which injects the oil into a shallow open-type combustion space, a low fuel consumption of the order of 0·37 lb. of fuel under full load conditions is obtained.

As previously mentioned, a light hinged cover of cast alloy construction permits free splash lubrication of the valves and valve gear within the cover, while at the same time sealing these working parts from dust and dirt. The pistons are made of high-

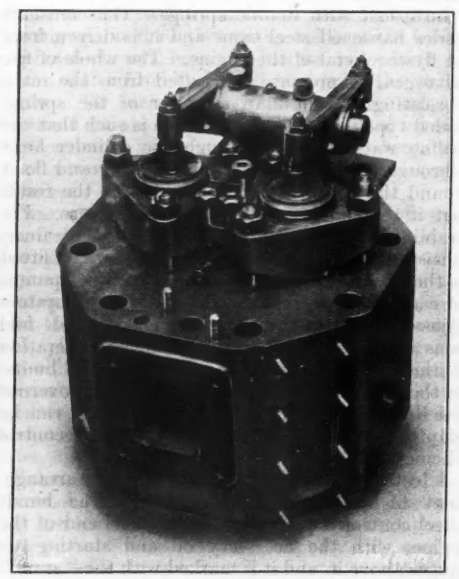


FIG. 171—CYLINDER HEAD—MIRRLEES

duty cast iron and they each carry three pressure rings and one oil scraper. For engines designed to run at speeds over 450 r.p.m. pistons of aluminium alloy are preferred. A separate fuel pump of C.A.V. or Bryce manufacture is fitted on each cylinder, the controls being such that the quantity of fuel delivered to the cylinders and the timing of injection are independently adjustable, while any cylinder can be cut out. The governor is furnished with a hand speed control mechanism, and the starting and manœuvring is carried out by one handwheel arranged at the end of the engine, which controls both starting air and engine fuel. Lubrication is effected by a gear pattern pump driven from the engine containing a dual type strainer. The cooling water is taken from a water manifold, and enters the cylinder heads at two separate external connections. Cooling water outlets are arranged on the cylinder heads and are fitted with a regulating valve and a thermometer. The design we have described is also representative of a range of engines with a slightly smaller cylinder capacity, having a bore of 12½in. with a stroke of 19in. This series is built in units of two to eight cylinders, with designed outputs ranging from 170 B.H.P. at 375 r.p.m. to 1240 B.H.P. at 500 r.p.m. when supercharged.

Another type of engine which was also to have been exhibited was the six-cylinder standard "U" type engine previously described in these pages, which has a cylinder casing of mono-bloc form and is totally enclosed with forced lubrication. This range embraces a series of engines from two up to eight cylinders with outputs of 67 B.H.P. at 500 r.p.m. and 600 B.H.P. at 900 r.p.m. when fitted with a supercharger. The bore of the cylinder is 8in., with a stroke of 12in., and a normal brake mean effective pressure of 88 lb. per square inch. A standard engine of a similar design, but with the stroke increased to 13½in., is also manufactured, and this series covers engines with two cylinders giving an output of 75 B.H.P. at 500 r.p.m. up to eight-cylinder engines having an output when supercharged of 635 B.H.P. when running at 750 r.p.m. The six-cylinder engine, which we illustrate in Fig. 154, on page 424, has, when unsupercharged, a designed output of 275 B.H.P. when as the Mark "ULB" engine it runs at 600 r.p.m., and 340 B.H.P. when as the Mark "U L C" engine it runs at 750 r.p.m. When running as a supercharged unit its respective outputs are as a Mark "ULBT" engine 400 B.H.P. at 600 r.p.m., and as a Mark "ULCT" engine 475 B.H.P. at 750 r.p.m. Our engraving shows a generator attached to the engine, but it was not intended to show a generator unit at Olympia. Other exhibits would have included a number of examples of the Mirrlees "IMO" pattern pump which is manufactured in a range comprising low, medium, and high-pressure units with a maximum delivery pressure up to 2500 lb. per square inch and a range of outputs from 1·8 gallons per minute up to 2000 gallons per minute. The design and characteristics of the "IMO" pump were fully described in the series of articles on "A History of Rotary Engines and Pumps" which was included in our issue of September 8th.

Ruston and Hornsby, Ltd.

The exhibits of Ruston and Hornsby, Ltd., which were to be on view at Olympia, would have been of unusual interest to visitors, as they were to have included some examples of a new range of medium speed cold-starting vertical oil engines, which have been recently introduced to replace the present Ruston VR series. They operate on the four-stroke principle, with airless injection of fuel, and may in the larger sizes of the range be supplied as pressure-charged units working in conjunction with a Buchi exhaust-gas-driven turbo-blower. The development of this new series of engines has been carried out over a considerable period of time, and we understand that quite a number of the new units have been in service for some while. The operating results show, we are informed, that the new design fulfils the makers' object of providing a series of smooth-running engines, with an improved fuel consumption, and incorporating that dependability at which Ruston designers have always aimed.

The principal differences between the new series and the one it replaces include the use of an open type of combustion chamber having overhead valves, and a new fuel injection equipment comprising a separate fuel pump for each cylinder which is mounted alongside the cylinder it serves, and has an atomiser of the Ruston Mark 37 pattern, which was recently introduced, and was fully described in our issue of February 10th, 1939. In accordance with the firm's practice, other minor improvements have been added to the design of these engines, the desirability of which has been shown by running experience.

In the table we reproduce below the power, number of cylinders, bore and stroke, and running speed are given for each size of engine, whether running with normal induction or pressure charged. The powers quoted are, it is stated, in accordance with the B.S.I. 12-hour rating, and are based on the conservating ratings commonly associated with Ruston practice.

It will be seen from the table that the new

range of engines provides a series of powers from 90 B.H.P. up to 1040 B.H.P., with engine units having from four up to eight cylinders, the engines all operating with normal induction. In the higher powers, the four larger cylinder sizes in six, seven, and eight-cylinder units giving a power range from 415 B.H.P. up to 1560 B.H.P. are available as pressure-charged units with Buchi exhaust turbo-blowers. The brake mean effective pressures of the new engines are of the order of 82 lb. to 77 lb. per sq. in. in the case of the normal induction engines, and 119 lb. to 116 lb. per sq. in. for the pressure-charged engines. These figures, like the fuel consumptions given in the table above, relate to the full load normal rating, with no overload.

Designed B.H.P. Outputs.		Number of Cylinders.	Bore and Stroke.	Running Speed. Revs. per Min.	Guaranteed fuel Consumption. Lb. per B.H.P. Hr.
Normal Induction.	Pressure Charged.				
90	—	4	6¾ in. × 9 in.	750	0·400
112	—	5	,,	750	0·400
135	—	6	,,	750	0·400
102	—	3	8 in. × 10¾ in.	600	0·390
136	—	4	,,	600	0·390
170	—	5	,,	600	0·390
204	—	6	,,	600	0·390
276	415	6	9 in. × 12 in.	600	0·385
240	—	4	10½ in. × 14½ in.	500	0·380
300	—	5	,,	500	0·380
360	540	6	,,	500	0·380
420	630	7	,,	500	0·380
480	720	8	,,	500	0·380
400	—	5	12½ in. × 15 in.	428	0·380
480	720	6	,,	428	0·380
560	840	7	,,	428	0·380
640	960	8	,,	428	0·380
650	—	5	15 in × 20 in.	375	0·375
780	1170	6	,,	375	0·375
910	1365	7	,,	375	0·375
1040	1560	8	,,	375	0·375

A typical engine of the series is the six-cylinder 480 B.H.P. unit shown in Fig. 157 on page 424, and in drawing Fig. 172. The engine has a bore of 12½in., with a stroke of 15 in., and runs at 426 r.p.m. Attention may be drawn to the sturdy design of bedplate with its deep oil sump and the robust crankcase casting which is bolted on top of it. The inspection doors are large, and in the case of the larger sizes of engine are hinged and secured by clamps. By this means doors may be readily opened or secured, and there is ample space for giving easy access to the main bearings and, when split pistons are fitted, for withdrawing the piston and connecting rod without dismantling the cylinder cover. The crankshafts are made from a solid steel forging, and the scantlings of the shaft are so chosen that the shaft is free from critical speeds and torsional vibration throughout the running speed range of the engine. At the junctions of the crankpins and journals with the crank webs there is a counterbored radius, the purpose of which is to do away with stress concentrations and give the requisite flexibility, also to avoid fatigue stressing. At the flywheel end of the crankshaft a double bearing is provided to take the additional load of the flywheel, which is bolted direct to the crankshaft flange. The cylinder liners are of the wet type and are made of special cast iron which when finished has a ground and honed surface, all liners being interchangeable. The pistons are made of heat-resisting cast iron, and are annealed after the rough machining has been done, and then finished, the piston body being ground to give the necessary clearance over its entire length at the working temperature. The piston-pin bores are chilled and ground and a floating gudgeon pin is employed. Inside the piston there is a light cover which is fitted in order to prevent lubricating oil or oil vapour from coming into contact with the heated dome of the piston. The piston carries five pressure rings and one oil-scraper ring on the skirt.

Separate cylinder heads are employed, which are iron castings, and carry the overhead inlet and exhaust valves, with their rocking levers and brackets, also the fuel atomisers and the air-starting valves. In all the larger sizes of engines the valve cages of the inlet and exhaust valves can be withdrawn from the cylinder head without having to remove it from the cylinder. The heads are well water-jacketted, and provision is made for the examination and cleaning of the cooling water spaces. As will be seen from the drawing, the valves and valve gear are completely enclosed by a light removable cover. The camshaft is housed within the column casting, and it is driven from the crankshaft by a silent-running chain with an easily adjustable chain tension regulator. The centrifugal governor is also arranged at the flywheel end of the engine, and hand-speed regulation is provided for. The governor regulates the quantity of fuel oil delivered to the engine cylinders by means of the Ruston fuel pumps, which, as our drawing shows, are placed alongside the cylinders they serve. A fuel filter is fitted in the fuel supply system on the suction side of the pump, and further filtration is provided by the edge-pattern strainers which are fitted to each of the atomisers. The arrangement of the exhaust manifolds and the air inlet manifolds, both for the normal induction and the pressure-charged engines, is clearly shown by the accompanying illustrations.

The forced lubrication system is supplied by a submerged pump of the gear type, which is gear-driven from the engine crankshaft, and delivers oil to all wearing surfaces, also the chain sprockets and the camshaft bearings. The oil pipes are large in diameter, and for starting purposes a hand-operated priming pump is provided. The lubricating oil is cooled by passing it through an oil cooler in circuit with the engine cooling water system. When necessary the design is such that a Streamline filter, shown in Fig. 174, which comes into operation as soon as the engine is started up, can be easily adapted. In practically all the engines the cooling water is circulated by a centrifugal pump, driven by chain from the main crankshaft.

The design outlined above is also adopted for the larger engines arranged for pressure-charging on the Buchi exhaust turbo-blower principle, which has been successfully adopted by the firm for some time past. The drawing we reproduce in Fig. 174 shows one of the eight-cylinder engines, with a bore of 15in. and a stroke of 20in., with a designed output of 1560 B.H.P. at 375 r.p.m. This drawing also shows the platform and handrails used with these larger units, and the mounting of the turbo-blower on a bracket at the end of the engine remote from the flywheel. The drawing reproduced in

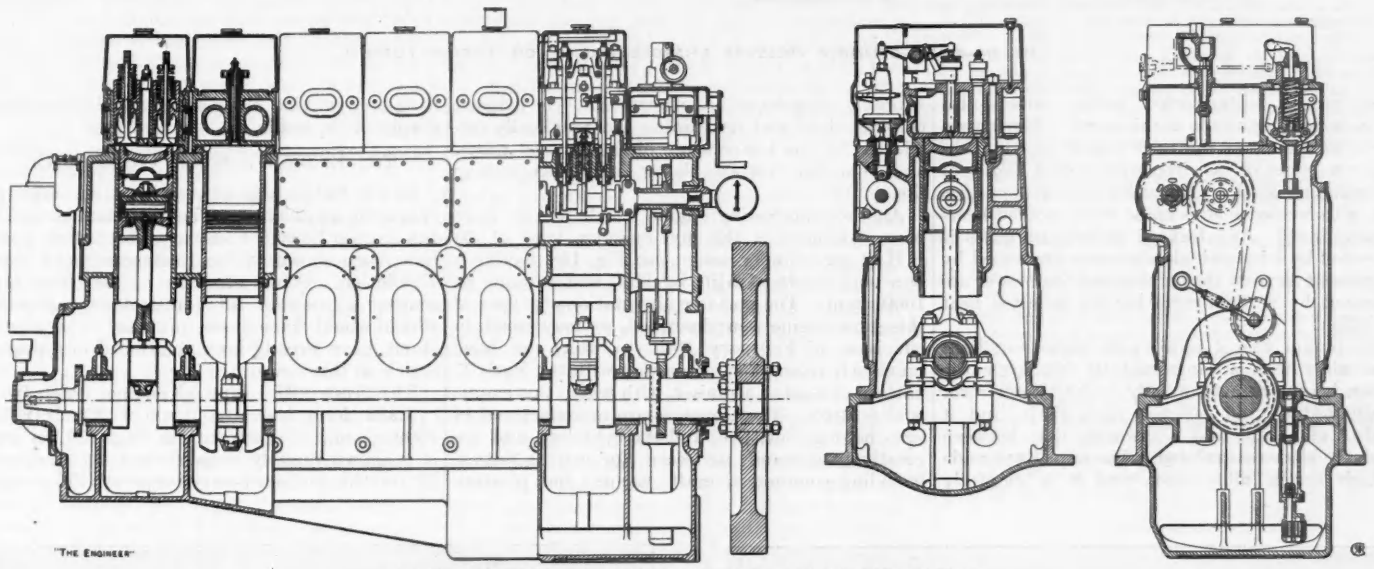


FIG. 172—SIX-CYLINDER MARINE AUXILIARY OIL ENGINE—RUSTON

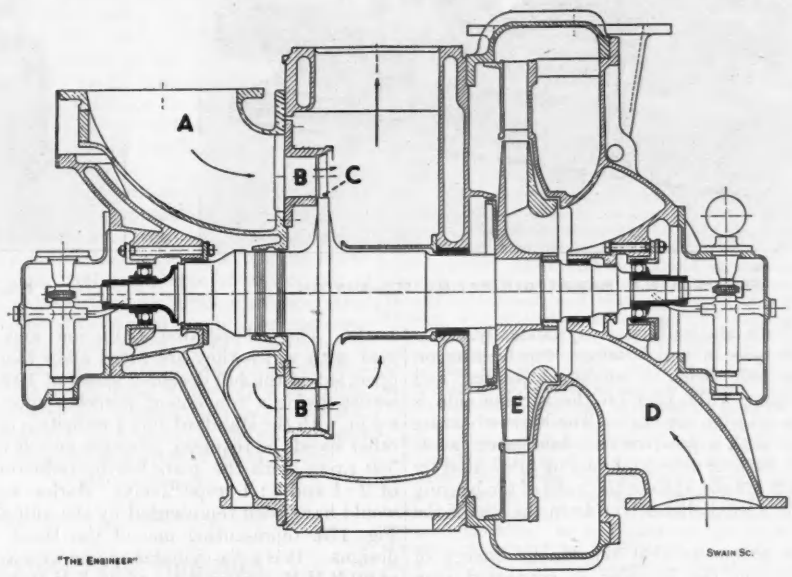


FIG. 173—SECTION THROUGH TURBO-BLOWER—RUSTON

Fig. 173 shows a section through the turbo-blower, which is of the single stage type, comprising a centrifugal blower driven by an exhaust gas turbine, both of these units being combined in one element. The turbine casing consists of two essential parts, the barrel with the exhaust connection and the inlet casing with the exhaust gas inlet branches. Both of these parts are made in cast iron and are bolted together. They are provided with a water-cooled jacket, which also carries a bearing at the turbine end. The nozzle ring is mounted on the inlet casing and it comprises two rings of cast iron with cast-in blades of heat-resisting steel. The turbine rotor is of disc form with welded blades made from profiled heat-resisting steel. Any leakage of exhaust gases is prevented by labyrinth glands which are sealed by compressed air, and the turbine and the blower are separated by a diaphragm having asbestos heat insulation.

The blower casing is a single casting in light metal alloy with a tangential air discharge, the suction being arranged axially. The blower rotor is mounted on the common rigid shaft, and it consists of a hub and a covering disc between which the blades are riveted. The impeller is made in high tensile alloy steel, and it is carefully balanced both statically and dynamically. The rotor shaft runs in ball bearings, the bearing on the blower side being a combined journal and thrust bearing, while that on the turbine side is free to expand with the heat. The blower bearing is provided with a positive feed lubricator, while that on the turbine side is oil-vapour lubricated by the oil which is flung against the walls of the bearing chamber by a small disc driven from the end of the shaft.

In order to ensure that the kinetic energy of the air leaving the impeller is converted into pressure under as favourable conditions as possible, a diffuser with fixed blades surrounds the impeller and is fitted into the blower casing. As in the case of the turbine, labyrinth glands are fitted to the blower, these being of such a design that they can easily be renewed.

As indicated by the arrows shown in Fig. 173 the exhaust gases enter the turbine at "A" and pass through the nozzles "B" to the turbine rotor "C," from which their energy having been extracted they pass to the atmosphere as shown by the directional arrow. Air for pressure-charging is drawn into the centre of the blower through the passage "D" and is delivered by the impeller "E" through the diffuser to the engine manifold. Running experience has shown that the exhaust turbine wheel and its blading are practically unaffected by the temperature of the exhaust gases, and that the turbine-blower unit has a long life.

Another interesting engine which was to have been exhibited is the five-cylinder type of 20 B.H.P. per cylinder design, see Fig. 158, having a bore and stroke of 5¾in. by 8in., and running at 1000 r.p.m. The portable and stationary types of this same engine were described, we may recall, in our issue of February 10th, to which we have previously referred in connection with the Mark 37 pattern of Ruston atomiser, with which this engine is also fitted. These engines are manufactured in sizes having four, five, and six cylinders, and are greatly in demand, we learn, for marine duties, including commercial craft, yachts, and pleasure boats. The oil-operated reduction and reverse gear with which they are fitted allow them to be operated at the full designed speed of 1000 r.p.m., whilst giving a convenient propeller speed of 400 r.p.m. with the standard 2·5 : 1 reduction or, should other speeds be required, propeller speeds of 500 or 300 r.p.m. with the gears having reduction ratios of 2 : 1 and 3 : 1 respectively. Marine auxiliaries would have been represented by the unit shown in Fig. 175, representing one of the latest Ruston designs. It is a six-cylinder engine with an output of 60 B.H.P. continuous, and 66 B.H.P. maximum output, and is also available in the five-cylinder size as a 50–55 B.H.P. engine, and as a three- and a four-cylinder engine. Finally we show in Fig. 153 a marine auxiliary unit comprising a 7½ B.H.P. Ruston oil engine driving a 4 kW generator and a small air compressor. The engine has a bore of 4½in. and a stroke of 4½in. and develops its full power when running at a speed of 1000 r.p.m.

The boiler department of Ruston and Hornsby, Ltd., would have been represented by a horizontal type Thermax boiler, having a length of 10ft. and a diameter of 6ft. 6in. with a designed output of 3070 lb. of steam per hour from water at 60 deg. Fah., used for feed purposes, while types of fusion-welded air receivers, built to Lloyds Register Survey, would have been on view along with typical X-ray photographs of the welds.

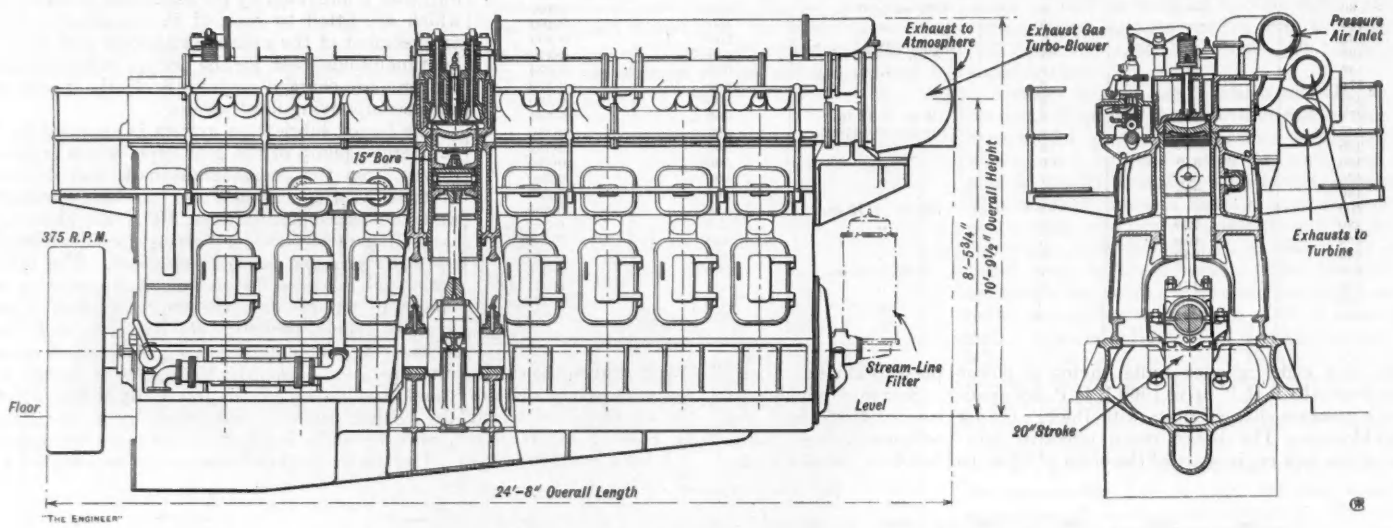


FIG. 174—EIGHT-CYLINDER PRESSURE CHARGED MARINE OIL ENGINE—RUSTON

The English Electric Company, Ltd.

In Fig. 160 on page 424 and in the accompanying engraving we illustrate oil engines manufactured by the English Electric Company, Ltd., which were to have been shown at the Engineering and Marine Exhibition. Other products of the firm, representing a range of A.C. arc welding equipment, which would have been on view on a separate stand, have already been mentioned in a previous article in this series.

The firm's "H" type oil engine, which in six-cylinder form has an output of 220 B.H.P. at 1500 r.p.m., is illustrated in Fig. 176, in which it is shown directly coupled to a D.C. generator, for traction and stationary purposes. This engine, like the larger high-speed units manufactured by the company, is arranged vertically with open combustion chambers and direct mechanical injection; it operates on the four-stroke cycle, each cylinder being provided with two inlet and two exhaust valves. The cylinders have a bore of 6in. and the stroke is 8in.

For traction purposes the lower half of the crankcase is usually made of cast steel and a flanged register is provided so that the generator can be attached closely. Cast iron is employed for the upper half of the crankcase and the cylinder block. Wet liners are fitted and there are large inspection doors giving access to the main and big-end bearings; separate openings are provided for inspection of the camshaft. In order to permit free expansion and contraction, the liners are registered at the top ends only, the joint at the

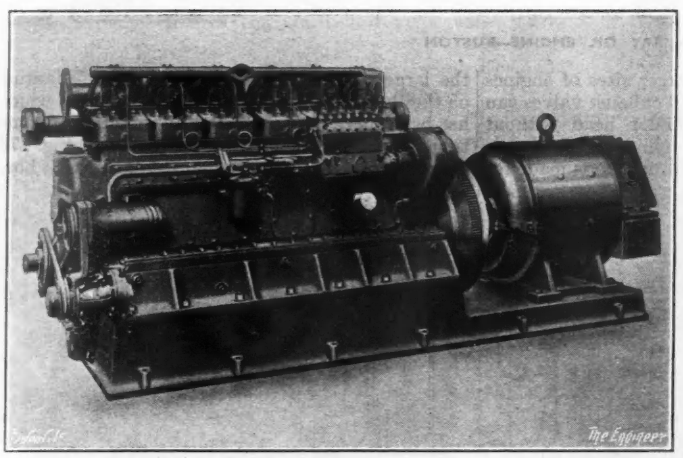


FIG. 175—60 H.P. MARINE GENERATING SET—RUSTON

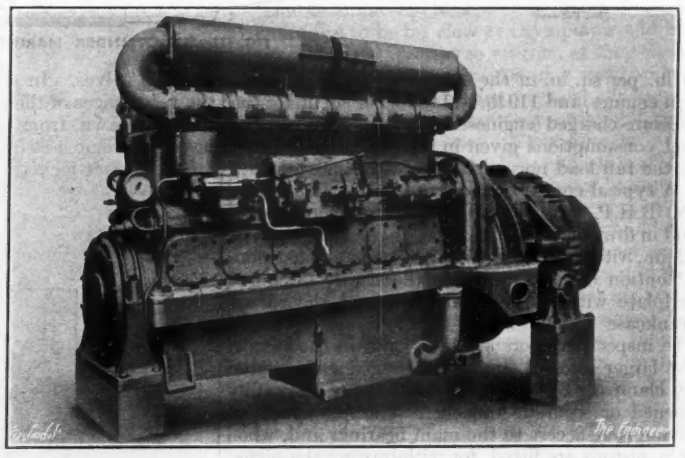


FIG. 176—220 H.P. GENERATING SET—ENGLISH ELECTRIC

lower end of each liner being made by two rubber rings.

Arranged vertically in each cylinder head are four valves, operated by push-rods through rocker gear. A triple-chain drive operates the camshaft, mounted at mid-level, from a sprocket at the flywheel end of the crankshaft. The crankshaft itself is made from a solid steel forging and is carried in seven main bearings. At the front end a vibration damper is mounted. Pistons are of heat-treated aluminium alloy and the crowns are specially shaped so as to set up a turbulent motion of the air during the compression stroke. Each connecting rod, with its piston, can be withdrawn through the appropriate crankcase inspection door, thus reducing the work of dismantling.

The fuel pump and governor are driven from the camshaft through gears, and another chain drives the circulating water pump, on the other side of the engine. Fuel injection equipment is of C.A.V.-Bosch manufacture, fuel being controlled by a variable speed-range governor built integrally with the fuel pump. Automatically variable timing of the beginning of the injection period is also provided in this design. An independent and separate governor is arranged to shut off the fuel supply at 1650 r.p.m. Other safety devices interrupt the electrical control circuits of the governor and stop the engine should the lubricating oil pressure fail or should there be insufficient cooling water.

For circulating the lubricating oil a chain-driven pump is used. The oil is stored in the engine bedplate sump and is fed to the crankshaft main bearings, camshaft bearings, and valve gear. Lubrication of the big-end bearings is effected by forcing the oil from the main bearings through passages drilled in the crankshaft, while the small-end bearings and pistons are splash and mist lubricated. There are no high-pressure oil pipes or unions outside the crankcase.

The "K" and "L" type engines made by the firm are also of the vertical, totally-enclosed type, operating on the four-stroke cycle. "K" type engines are available with any number of cylinders from three to eight, with outputs ranging from 165 B.H.P. to 440 B.H.P. at 600 r.p.m. The cylinder bore is 10in. and the piston stroke 12in. in this design. Built mainly to the same specification, the "L" type engine can have from four to eight cylinders, with outputs from 500 B.H.P. to 1000 B.H.P. at 360 r.p.m., and with cylinder bores of 15 in. and piston strokes of 20in. These engines are applicable to many uses, including electricity generation, traction, marine, and other duties.

A seven-cylinder "L" type oil engine, similar to the unit which would have been on show, is illustrated in Fig. 160 on page 424. This unit has an output of 875 B.H.P. at 360 r.p.m., and is shown directly coupled to an alternator.

In the "K" and "L" type engines, the bedplate is of cast iron, with the main bearing housings supported by webs. The bed-plates are cast in one piece, with the exception of that for the eight-cylinder 1000 B.H.P. engine; in this case the bedplate is in halves, joined together with fitted bolts. An oil channel is cast round the outside of the bed-plate. On engines intended for marine propulsion an under-slung bed-plate is employed.

Of substantial proportions, the crankshaft is forged solid from a single bloom, and provides large bearing areas. It is machined all over and is made to the requirements of Lloyd's Register of Shipping. In the cases of the seven-cylinder 875 B.H.P. and the eight-cylinder 1000 B.H.P. engines the crankshaft is in halves, registered and bolted together. The crankcase is of cast iron; it is designed so that the main and big-end bearings are readily accessible. The casing is bored to receive the cylinder liners, and on the larger series a concentric distributing wall is provided in the casing to ensure a definite and symmetrical flow of cooling water round the surfaces of the liner. Large inspection doors are arranged for cleaning the water spaces.

Cast iron cylinder liners, machined externally to match up with the landings in the crankcase, are adopted. To permit expansion and contraction the liners are fixed at the upper ends only, and are made a light fit in the crankcase to prevent distortion or difficult withdrawal. At the lower end of the liner the water jacket joint is made by two rings of a synthetic rubber material, which is claimed to withstand the action of water, oil, and heat.

A special heat-resisting cast iron is used for the cylinder heads. They are provided with machined seatings for the inlet, exhaust, and air-starting valve cages, and for the fuel injector. The entire surface of the combustion side of the cylinder head is also machined. The cooling water is led from each cylinder jacket to the cylinder head by external connections. Also made of heat-resisting cast iron, the pistons are ground to graduated clearances claimed to give the maximum transference of heat with minimum friction. Three pressure rings and two scraper rings are fitted; one of which is situated above, the other below, the gudgeon pin. The gudgeon pins, of case-hardened steel, are of the floating type with adequate provision for lubrication over the whole length of the bearing surfaces, and are bored out to reduce their weight to a minimum. Caps secured to the piston bosses provide an oil-tight joint and locate the gudgeon pin.

Driven from the flywheel end of the crankshaft by a roller chain is the camshaft. Readily accessible tensioning gear is provided for the chain. The inlet and exhaust valve cams on the "K" type engines are of steel, case-hardened on the working surfaces; those for the "L" type are of chilled cast iron. The fuel injection cams on both types of engine are of steel, case-hardened on the working surfaces. They can be removed without disturbing the camshaft.

Push-rod operation, through rocker gear, has been adopted for the valves, which are arranged vertically and have large dimensions and long guides. Inlet and exhaust valve cages are provided so that any valve, complete with its cage, can be removed without disturbing the cylinder heads. The fuel injector and air-starting valves are automatic in action, and are opened by the pressure of the fuel and starting air respectively. A pressure relief valve is fitted on each cylinder head. The design of the valve gear is such that any cylinder head can be removed complete with its valves. The whole of the valve gear is lubricated from the pressure system, and is enclosed by easily removable covers.

A fuel pump is provided for each cylinder and is fitted as near its fuel injector as possible. The fuel pumps are operated from the camshaft. Each pump is provided with individual adjustment for distributing the load evenly over all the cylinders.

Through bevel gears a centrifugal governor is driven from the crankshaft. It operates directly on the fuel injection pumps, and care has been taken in its design to reduce internal friction by the use of ball bearings and by continuous automatic lubrication. It is therefore claimed to be very sensitive. We are informed that it is capable of speed adjustment of 5 per cent. above or below the normal engine speed by hand regulation while the engine is running. The standard variation in speed on sudden application or removal of full load is stated to be 7 per cent. momentarily, and 4 per cent. permanently. Regulation of the fuel is carried out by the angular movement of a shaft mounted on the crankcase and operated from the governor. The movement of the shaft is communicated by levers to the racks turning the plungers of the fuel pumps.

Automatic pressure-feed lubrication for the engine is provided by a gear pump, driven from the crankshaft, which delivers oil from the sump tank through a strainer and oil cooler to a main rail inside the crankcase. Connections are made from this main pipe to the crankshaft main bearings and other important points. A lubricating oil cooler is provided as standard, in the form of an independent unit fitted on or near the engine at the lubricating oil pump end. The whole of the cooling water is normally led through the oil cooler before entering the engine.

The form of the fuel consumption curve for these engines is claimed to be practically level from half load up to 10 per cent. overload. Since generally engines work on fluctuating loads averaging about 60–70 per cent. full load, this characteristic is claimed to be important for economical operation under service conditions, and much to be preferred to a low specific consumption at full load only. A further point is that the minimum fuel consumption value does not lie close to the full load figure, nor does the curve rise suddenly beyond this point. These two features are claimed to indicate a good mechanical efficiency and a conservative rating.

(*To be continued*)

Priority of Supplies

1. In the field of manufacture and supply the National effort must now be directed to the following ends:—
   (*a*) The equipping and maintenance of the Armed Forces.
   (*b*) The maintenance of essential National Services.
   (*c*) The maintenance of sufficient export trade to produce enough foreign exchange and as far as possible of our internal trade also.

2. It would be impossible, even if it were considered desirable, to lay down a hard and fast order in which these three requirements should be met because they are all required to bring the war to a successful conclusion.

3. As regards the direct requirements of the Government in the immediate future the available industrial capacity has to a large extent been surveyed and the output of certain firms has, with their agreement, been allocated between Departments. This is a framework on which to place present orders, but additional capacity is required, and it is intended to continue the practice of allocating capacity in suitable cases. Firms will be informed of allocations when made, and those firms whose capacity is allocated should be able to rely upon as long a run as possible of a particular product or products and so avoid the waste of effort entailed in changing from one line of production to another.

4. There has been a good deal of misapprehension in regard to the issue of priority certificates which may be due to the fact that, in 1917–1918, a "Priority Certificate" was usually required before any work could be done or materials obtained. If priority certificates become necessary during the present war the system under which principal and subsidiary priority certificates are to be issued and the Classes into which Priority Orders are to be divided are those set out in the Priority of Work Order, 1939, No. 1080.

But this general system of priority has not yet become necessary, and it is not at present intended to issue Priority Certificates on any substantial scale because a general issue now on the scale obtaining during the last war would merely lead to delay and tend to upset the even flow of production which is essential for the efficient prosecution of the war.

5. To the extent that the system of granting Priority Certificates under the Priority of Work Order, 1939, September 3rd, 1939, is brought into operation, the only authorities who will be empowered to issue them are the Government Departments concerned. No other certificates or directions purporting to be of a "Priority" nature can be properly issued or legally enforced.

6. The supply of raw material is in some instances under control. There is no general shortage of raw materials. If firms you have any difficulty in this direction they should apply to the appropriate Control for assistance. Controllers have been instructed to give preference to the allocation of materials where reasonable information can be provided to show that the materials are needed for Government work or for work on essential National Services.

7. As a very general guide, and having regard to the foregoing observations, the following summary may be of assistance.

   (*a*) Other things being equal, orders should be carried out in the order in which they are received.
   (*b*) Difficulties in regard to raw material should be referred to the Controller concerned.
   (*c*) *Priority Certificates having legal force will only be issued when necessary by order under the direction of the Government Department concerned.* The appropriate Department will be the Department placing the order under execution (or the main contract from which a sub-contract has issued); or the Department generally responsible for the particular industry or Service concerned. As an example, the appropriate Department in the case of work or material for the Export Trade will be the Board of Trade.

The Dartford–Purfleet Tunnel.—Work has been stopped on the construction of the tunnel under the Thames at Dartford, and a small maintenance staff has been placed in charge of the works completed to date. It is announced that the pilot tunnel, completed last year, has been made safe.

West of Scotland Iron and Steel Institute.—As a consequence of the restrictions on lighting and transport, and because of the general war work of the members, the Council has decided that it will be inadvisable to hold any meetings until further notice. Otherwise the Institute will carry on. Papers will be obtained as usual and will be published in the Journal, with discussion invited by correspondence. This will be submitted to the author of the paper for reply and finally published in a subsequent Journal.

Oil Frothing and Bearing Durability.—The object of a research, which has only recently been started, by the Institution of Automobile Engineers, is to study the problem of oil frothing as experienced in aero engines. The frothing is largely due to the fact that with the usual dry sump system, the scavenge pump has a larger capacity than the pressure pump, so that it inevitably sucks in a certain amount of air with the oil. An apparatus has been developed in which a gear pump draws oil from an electrically-heated tank, and at the same time air is admitted through a calibrated orifice gauge and a variable needle valve in the suction line. The pressure pipe is fitted with a glass inspection chamber and a pressure release valve, and the oil is finally delivered either back to the supply tank or into a measuring vessel. Methods of measuring the "frothiness" of the oil are being developed. A study of the flow of frothy oil through bends and pipe junctions is being made by incorporating a piece of glass tubing of the required shape in the pressure line. Methods of de-aerating frothy oil are also being examined. At a later stage, it is proposed to study the effect of frothiness on the durability of bearings, using a newly-designed machine. In this machine the big-end of a standard connecting rod is mounted on a rotating shaft while the small-end is attached to the short arm of a flexible lever. The long arm of this lever is connected, by means of a link, to an eccentric gear of variable throw which applies an alternating load to the big-end bearing under test. The shaft and the eccentric gear are driven by an electric motor at the same speed so that during one rotation of the shaft the bearing is subjected to one cycle of loading. Bearing temperatures are measured by a thermocouple embedded near the bearing surface. An optical device, consisting of a light source and mirrors, is being designed for controlling bearing load according to the deflection of the flexible lever.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

British Trade with Rhodesia

The Report on Economic and Commercial Conditions in Southern Rhodesia, Northern Rhodesia, and Nyasaland, published by H.M. Stationery Office, price 1s. 3d. net, shows that during 1937–1938 on the whole British traders continued to obtain a satisfactory share of the import business with these countries. In 1938 Northern Rhodesian imports from Great Britain were substantially larger than previously. The British share of the total imports was 43·5 per cent. as against 36·8 per cent. in 1937 and 39·5 per cent. in 1934. Machinery for the mines, however, accounted for one-third of Northern Rhodesia's imports in 1938 and for less than a quarter in 1937. For this reason it is difficult to compare the trade for the two years. Nyasaland has only a small import trade, the British share of which tends to drop. It is pointed out that lately in the Rhodesias a large demand has developed for cheap ploughs for use by natives on their own land, and the imports of these implements are probably three times as large now as they were a few years ago. The demand, hitherto, has been to the benefit of Germany, Czechoslovakia, and Poland, whose exporters' price c.i.f. Beira for a single furrow plough was less than £1. When the implement works which are to be established in Bulawayo come into production this trade may receive a setback. The British share of the imports of electrical machinery declined owing to the purchase from Germany of transformers and motors, and from Sweden of motors. New competition in storage batteries is coming from the Union of South Africa and a large part of the demand for dry batteries is supplied by the United States. Great Britain held a leading place as an importer of mining machinery including buckets and tip-trucks in Southern Rhodesia. In 1937 her percentage was 39·5 compared with 18 per cent. from South Africa, 6·1 per cent. from Germany, and 35·3 per cent. from the United States. In 1938 the British share was 41 per cent. compared with 16·3 per cent. from South Africa, 8·5 per cent. from Germany, and 33·2 per cent. from the United States. The British percentage of the whole trade with Northern Rhodesia in 1937 was 45·7 against 10·2 per cent. from South Africa, 5·7 per cent. from Germany, and 34·4 per cent. from the United States. It is pointed out that Germany's appearance in this trade is due to her preponderating share of the trade in battery shoes and dies and her less important competition in buckets and tip-trucks. In other types of mining plant the United States has gained at the expense of Great Britain. In manufactured steel, including angles, channels, bars, plates, and rods, the British share in 1938 in Southern Rhodesia was 41·7 per cent., Belgium coming next with 25·8 per cent., whilst in Northern Rhodesia Great Britain sent 45·1 per cent., South Africa 37·3 per cent., and the Belgians 14·4 per cent. Great Britain, however, sent less drill steel to Southern Rhodesia than Sweden, the respective proportions of the whole trade in 1937 being 27·9 per cent. and 63·7 per cent., and in 1938 25·4 per cent. and 68·4 per cent.

Some Export Problems

Some interesting references were made to the export trade at a meeting of the South African Section of the London Chamber of Commerce recently. In the course of his address the Chairman said that a considerable volume of complaint had arisen as to the high rate of premium charged for the insurance of stocks in sellers' hands and the methods adopted in applying it. He referred to the difficulties arising from the insurance of goods in transit and in packers' warehouses prior to shipment, but the Board of Trade had now approved the following clause for inclusion in policies: "Warranted goods are covered from the time of leaving the premises of the supplier and/or whilst in transit to and/or whilst in any other packing warehouse for the purpose of repacking for export, and to continue during the ordinary course of transit until the goods are on board the overseas vessel." This clause covered not only firms which bought ex-warehouse and shipped to their own houses in South Africa through the ordinary packers, but also agents for South African buyers. There had been delay and difficulty in obtaining licences and in getting goods shipped, but the Government Department concerned was issuing licences faster than applications were being received, and it was hoped shortly to overtake arrears. Referring to the delays which occurred at the docks, the Chairman pointed out that it had to be recognised that it was the duty of the Customs to see that goods did not go out which were on the prohibited list, and that a scrutiny of the various items on the free entry and sometimes the examination of the goods must take time. The Chamber had suggested that the regulations should be relaxed in the case of shipments to the Dominions and Colonies, but it had been pointed out that there were considerable difficulties in the way even where the Dominions were concerned and some sort of a check had to continue. Steps had been taken to organise the British owners of cargo in German vessels lying in neutral ports with a view to securing their release. The Chamber had obtained a large volume of information as to the position of vessels and the ownership of cargo.

The Pig Iron Market

A gradual increase in the demand from all departments of the consuming trades is being experienced. Firms in the light castings industry are being given Government work on a larger scale, and as a result business in high phosphoric iron is expanding. There is no scarcity of this material and the improvement in the demand is welcomed in view of the slack time which was experienced by the producing industry during the first half of the current year. Other grades of foundry iron have been passing into consumption on a more important scale since the war commenced, and the activity now shows signs of spreading to the forge iron department which has experienced only a quiet demand for several months. On the north-east coast consumers are getting their full supplies although in this district a number of users have contracts with Midland producers to work off. The decision to remove the import duty on foreign pig iron is unlikely to affect consumers in this area as their full requirement can be obtained locally. There are reserves of No. 3 Cleveland iron and this enables the pig-iron makers to concentrate upon the production of basic iron which is being used in heavy quantities by the steelworks. Comparatively little new business has been transacted of late in Cleveland iron and for the time being none of the latter description is being made. In the Midlands interest is shown chiefly in low phosphoric grades, although with the improvement in the position at the light castings foundries, more high phosphoric iron is passing into consumption. Investigations are understood to be in progress by the Control to discover what stocks exist at the consuming works as well as at the producing establishments, and when these figures are completed it should enable the Control to regulate supplies. The impression is that consumers who have accumulated stocks will have to use them whilst those in a less fortunate position will receive fresh supplies. It is understood that the reserves of the different brands in hand vary considerably, and that whilst stocks of Northamptonshire foundry iron are, apparently, rather low, Derbyshire iron is in much freer supply. No announcement has yet been made as to the control of the price of low phosphoric pig iron, and it is anticipated that this will be made when the new prices which will come into force at the beginning of November are published. Business in the Scottish pig-iron market has expanded considerably of late, and in some cases the works are getting into arrears with deliveries. It is believed however, that in many cases consumers have ordered more iron than they required as a precaution against scarcity developing later in the year. In the hematite market the demand appears to have outrun production, but the makers have good stocks from which to meet consumers' requirements.

Scotland and the North

A large volume of orders continues to reach the Scottish steelworks and there is inevitably some delay in deliveries. Great efforts, however, are being made by the steelmakers to keep abreast of the demand, and these are meeting with more success than pessimists believed possible. The careful planning by the Control is also helping to keep supplies moving regularly to consumers. All the available plant is kept fully employed and pressure is particularly great from users engaged upon Government work; but some relief has been afforded the steelmakers by the suspension of schemes of a private character. The constructional engineers for the most part have full order books and are engaged upon important work. The outlet in this direction for joists and sections is on a huge scale and firms desiring to place new business are finding it difficult to arrange for anything like near delivery. The shipbuilders on the Clyde are almost fully occupied, and large tonnages of shipbuilding sections and plates are required. The demand for steel material from this industry is likely to continue heavy for a long time. Firms engaged upon general engineering are actively employed upon a variety of work most of which arises directly or indirectly from Government projects. The marine engineering section, also, has more work in hand than for a long time, and its requirements of steel material appear to be gradually expanding. Recently a Scottish firm secured an order for twenty locomotive boilers for India and this, with the work on home account already in hand, will necessitate large supplies of steel for some time. The consuming industries in Lancashire are fully occupied in nearly every instance and as a result the pressure upon the steelworks is heavier than has been experienced for many years. The constructional engineers are taking considerable quantities of joists and sections and reinforced concrete bars; whilst the boilermakers and tank makers have enough work in hand to keep them busy until well into next year. The wire industry also is fully occupied, whilst there is a vigorous demand for alloy and special steels. The production of bright steel bars also is being well taken up by the engineering industry and is at a high level.

The Midlands and South Wales

The entire production of the Midland iron and steel works is passing immediately into consumption and, although outputs are maintained at record levels, there is a tendency for the works to fall into arrears with deliveries. This is noticeable chiefly in the structural steel section of the market, and in spite of the huge tonnages of joists, angles, and tees which are being turned out, there is continual pressure on the part of consumers to secure delivery and to get new orders accepted. None of the makers are anxious to take fresh business as they already have several months' work in hand. It is known that prices are under consideration and it is expected that the new quotations, which will rule after October 31st, will be published shortly. The market anticipates an advance in home as well as export quotations. A number of schemes of a private and semi-public character which would have been proceeded with had war not intervened, have been suspended and this has relieved to a slight extent the pressure upon the works. So great are the demands upon the steelmakers for war purposes, however, that there is little surplus for commercial or export orders. The request for plates of all thicknesses has grown considerably in volume since the middle of last month and it is not easy to place contracts for delivery within a reasonable period. The boiler makers, tank makers, and locomotive builders are insistent in their demands and the platemills are being operated at full capacity. The Midland re-rollers are taking up large supplies of billets, but are unable to obtain all the material they require and their output is to some extent restricted. In some parts of the country the recently instituted rationing arrangement appears to have eased the situation of the re-rollers and it is said that the present stringency in the Midlands will be of short duration. The sheetmakers are so well occupied upon A.R.P. and other Government contracts that they have little opportunity of accepting ordinary commercial business. A certain amount of this class of trade, however, is being conducted, but consumers think themselves fortunate in being able to place orders for delivery in six to eight weeks. The South Wales steel trade is working at capacity but is unable to meet completely the requirements of the tinplate makers. During September the production of steel in the district averaged 28,650 tons per week, compared with 17,240 tons for the corresponding period of last year. The tinplate market is active and overseas buyers are pressing orders upon the works. In some markets it is easy to obtain 28s. f.o.b. Bristol Channel ports, per standard box, although the maximum official home trade price is 20s. 4½d. f.o.t.

Copper and Tin

Although in the ordinary sense of the word there is no market in electrolytic copper consumers appear to be kept well supplied. So far the chief trouble seems to be that some users have been unable to obtain the brand of copper they wanted just when it was required. This may be inevitable under the conditions ruling at present, but it is none the less irritating. Merchants also are in the position of having to buy and sell their copper at the same price and so are debarred from making any profit. Nevertheless, rather than lose old connections some merchant firms continue to transact business although they are unable to cover even their expenses. Discussions upon the position of the metal merchants have been taking place with the Ministry of Supply, and it is hoped that they will be allowed to charge a commission or in some way be permitted to receive a reasonable profit. Considerable quantities of copper are passing to the consuming works, most of whom are engaged upon work of national importance, and supplies are apparently assured for some time. The Ministry of Supply has now agreed with the London Metal Exchange upon a scheme for closing the accounts open at the commencement of the war. The arrangement provides that the merchants will hand over to the Government their stocks of copper and the Ministry will join the London Metal Exchange clearing, the closing of open positions being entrusted to the London Metal Exchange staff. Each broker who is long or short on the date of the clearing will be able to make a covering contract with the Ministry. This seems a satisfactory solution to the problem. In the United States it is pointed out that the domestic sales during September reached a figure of 183,626 tons (short), which was a record for any month. To September 30th this year the sales in the United States reached 654,133 tons, against a total for the same period of 1938 of 514,067 short tons. The rush of buying, however, appears to have receded, but the producers are keeping their official domestic price at 12.50c. although business has been done at a higher figure. . . . The tin market has been given an opportunity of testing the plan by which the Buffer Pool places a certain amount of cash tin daily at the disposal of the Metal Exchange, the tonnage being allocated amongst the members by a Committee. Apparently the allocations amounted to between 25 tons and 50 tons per day, and so far as can be seen the plan is working successfully. Consumers also have benefitted by the arrangement as they have been receiving more regular supplies. It is expected that the quantitites which have been made available for the Metal Exchange will be increased later on and it is not anticipated that there will be any shortage of supplies. It is reported that the Arnhem Smelter in Holland may be obliged to close down as tin ore and concentrates are regarded as contraband. At the same time the Dutch Government has prohibited the export of tin.

Lead and Spelter

A large tonnage of lead is required to meet the needs of the consuming industries, but whilst the London market is suspended it is impossible to give details of the position. It is suggested that there has been a falling off in the requirements for ordinary commercial purposes, but if this is the case the war demand has more than made up for it. Naturally, at a time like the present, the possibility of increasing the domestic production of lead is canvassed and recently the Secretary for Mines was asked in the House of Commons if he would cause inquiries to be made into the possibility of reopening the lead mines in Carmarthenshire. The reply was that the mines had been dismantled in 1930, the machinery sold and the rails, both surface and underground, taken up. Reopening, therefore, would take a long time, and owing to the remoteness of the mines, the prospect of their being successfully worked was somewhat speculative. The Minister added that there was no shortage of lead and that none was anticipated. The American market remains active and the price is firm at 5.30c. . . . There is a strong demand for spelter in this country as large quantities are being used for Government purposes. All the consuming industries are busy and not only are the galvanisers taking large quantities, but there is an active business passing with the brassmakers. Consumers in this country are finding no difficulty in obtaining supplies and it is not expected that any shortage is likely to develop although as the war progresses it is probable that the uses of the metal will expand. There is some expectation that a new Order relating to zinc sheets may be issued by the Non-Ferrous Metal Control. It is not easy to place orders for the latter material and it is pointed out that imports are impossible as the price of zinc sheets on the Continent is slightly higher than the official maximum of £29 ex-works, fixed by the Control.

French Engineering Notes

(From our own Correspondent in Paris)

Armament Organisation

THE duties of the Minister of Armaments, Monsieur Raoul Dautry, are now specified as controlling expenditure on armament production, organising engineering and metallurgical works and factories, and taking over the entire production of explosives and chemical products. He also controls other industries working for national defence, as well as labour required for the work. He will do all that is necessary to ensure that the country's resources are utilised to their uttermost by means of a co-ordinated plan in a manner to supply whatever is required at the right moment and at the right place. Works' equipments will be extended wherever possible. Attention will be given to the internal organisation of works and factories which must keep pace with military needs, and new establishments may be created, if necessary, to produce up to the limit of the raw material supplies available. For this part of his task Monsieur Dautry has appointed as general inspector of armaments Monsieur Surleau who, like himself, is a distinguished railway engineer and administrator, and was entrusted by the Government some months ago with the duty of administering the affairs of Marseilles that had fallen, through mismanagement, into a hopeless state of confusion. The transference of Monsieur Surleau to his new post is for the duration of the war. One of the first steps undertaken by Monsieur Dautry was to ensure a perfect unity of effort amongst employers and workers in producing the maximum output required for national defence. He held a conference with Monsieur Lambert-Ribot, the employers' delegate, at the International Labour Bureau, Monsieur Jouhaux, the workers' delegate, Monsieur Lente, president of the Union des Industries Métallurgiques et Minières, representing all branches of the engineering and metallurgical industries throughout the country, and Monsieur Chevalme, secretary of the Federation of Metal Workers. The conference reached complete agreement on all points, and meetings are to be held in all industrial districts to crystallise this unity of effort. Another great organising task has been entrusted to Monsieur Albert Caquot in his new capacity of general director of technical and industrial services at the Air Ministry. Monsieur Caquot is past president of the Société des Ingénieurs Civils de France. His career is noted for outstanding examples of initiative and resource in dealing successfully with problems of public works that appeared almost insoluble. He created the construction dock at Saint-Nazaire which enabled France to build the largest ships afloat. At the time when French aircraft construction had fallen to a low ebb, Monsieur Caquot was appointed General Director of Aeronautics with the task of reorganising the industry, and he has now entered upon a similar duty, not to reorganise an industry that has made remarkable progress during the past year, but to co-ordinate both the technical and industrial services and accelerate a production that has already far exceeded the monthly output which the Air Minister, Monsieur Guy La Chambre, had fixed as his goal at the beginning of the year.

Skilled Labour Supply

The supply of skilled labour is a problem the solution of which is a vital necessity at a time when all industrial production is being extended to its utmost. There was a long period following the last war when the introduction of mass production methods in some industries created a class of specialised workers requiring no skill beyond what was needed for a particular operation. Good wages were earned by young men without going through long terms of apprenticeship, and the belief that this state of things would continue gave rise to a fairly general idea among the younger generation that apprenticeship was a superfluity. But the mass production system was found to have limitations in French industry. Specialised labour went to fill the ranks of the unemployed, and attention was again devoted to apprenticeship, which was now subjected to legislation in the interests of young workers that imposed too heavy a burden on employers as a class, although in big engineering works the training of young men was continued as necessary for their special productions. The vast majority of employers preferred to contribute to the cost of maintaining public and private training schools that, for the most part, gave indifferent results, and the State eventually organised a compulsory apprenticeship system which has not had time to demonstrate its effectiveness, nor is it at all probable that it may be able to turn out apprentices in sufficient numbers in the early future. While the supply of skilled hands remains below the normal needs of industry which was recovering activity before the mobilisation, the Government had to take special measures to keep pace with a much larger and increasing demand for men to work in armament factories. The Minister of Labour prepared a plan for an equitable distribution of skilled workers in the national interest which was put into operation when the general labour mobilisation was declared. All workers who are not mobilised for active service have to remain at their posts, and men whose work is indispensible in armament factories return to their jobs. Employers needing additional hands, or on discharging others, have to notify the labour exchanges, of which there are several kinds, public and private, and the labour exchanges communicate to the Minister of Labour a statement of employers' needs and lists of men waiting for employment. The Minister has a complete survey of the labour situation, and, in co-operation with the Minister of Armaments, distributes men among employers requiring them according to the necessities of national production. In this task he is guided by factory and other labour inspectors who know the more or less urgent character of the demand for men in each case. It is, however, not to armament production alone that the Minister gives attention. Private industry producing for national needs and for export must be carried on and developed as much as possible, and for that purpose the Minister has created a National Commission for the Co-ordination of Labour, whose aim is to make the best use of all the labour available and to increase the supply for the engineering and metallurgical industries by a more extensive organisation of instructional centres all over the country for the training of specialised workers.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

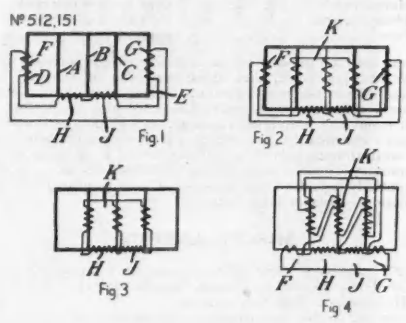
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSFORMERS AND CONVERTERS

512,151. *March 2nd*, 1938.—ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention relates to the suppression of harmonics in three-phase transformers. Fig. 1 of the accompanying drawing shows a transformer in accordance with our invention. The main windings on the three inner limbs A, B, and C have been omitted from the drawing, for the sake of clearness. The fourth and fifth limbs are marked D and E and carry windings G and F. The auxiliary windings H and J on the lower yoke between the main limbs are connected to the windings F and G to form a simple short-circuited winding. In the case of high inductions, the windings shown in Fig. 1 can be connected to a star-connected tertiary winding K on the main limbs, as shown in Fig. 2. The ratio of turns on the main limbs to that of yoke

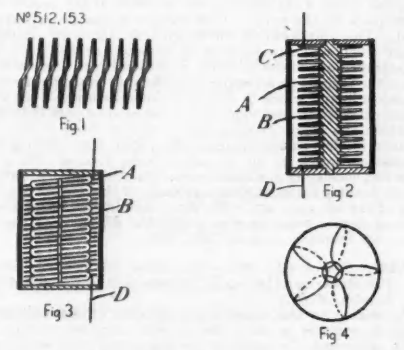


winding in this case should be 1 : 3. With the star-connected tertiary winding shown in Fig. 2, it is possible in cases of low core saturation to dispense with the windings FG on the fourth and fifth limbs. Such an arrangement is shown in Fig. 3. Instead of the star-connected tertiary winding of Figs. 2 and 3 for feeding the auxiliary windings, it is possible to make use of a delta-connected tertiary winding on the main limbs. Such an arrangement is shown in Fig. 4. In this figure, the auxiliary windings F and G are shown arranged on the extremities of the lower yoke, instead of on the outer limbs as in Fig. 2. It should be observed that with the delta-connected tertiary winding, the ratio of turns on the main limbs to that of the yoke winding should be 1 : 1, moreover tapping points giving a ratio of 2 to 1 turns of the delta tertiary winding on each of the main limbs should be connected to the ends of the auxiliary winding on the two yoke limbs, as shown in Fig. 4.—*August 30th*, 1939.

ELECTRICAL APPLIANCES

512,153. *March 10th*, 1938.—ELECTRICAL CONDENSERS, Sydney George Brown, F.R.S., of S. G. Brown, Ltd., Victoria Road, North Acton, Middlesex.

This specification describes condensers, particularly electrolytic condensers of fixed capacity having electrodes in the form of interlaced helical strips as shown in Fig. 1. Fig. 2 shows a cross sectional elevation of a type of condenser where both the positive and negative electrodes A and B are in the form of spirals or helices and interlaced. In this case, the container may be made of an insulating material such as cardboard, bakelite, or glass, and the central stem also of suitable insulating material. The central stem is arranged to have a double start thread in which the spiral electrodes are engaged. The lead of the double start thread will be equal to the required distance between the convolutions of one electrode and the pitch of the thread will determine the spacing between the convolutions of one element and the convolutions of the other. For the purpose of electrical connection, wires or extension

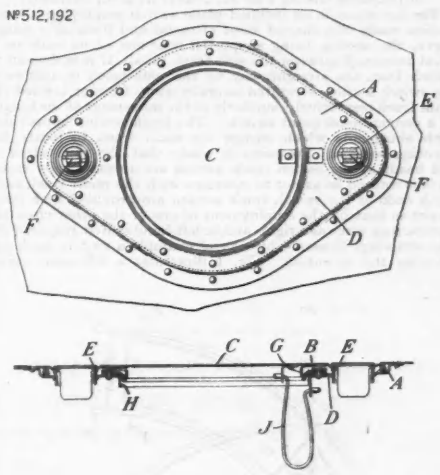


pieces CD can be attached to the end of each electrode by any suitable means such as a welding or rivetting operation. Where a dielectric is used, such as oil or wax, as opposed to an electrolytic condenser, a similar construction may be used and furthermore the central stem may be dispensed with and the convolutions insulated by an oxide coating, enamel, and the like. Alternatively a coil of suitable insulating material may be wound between the two helical electrodes and in each of the latter cases the coils may be compressed mechanically together and thereby vary the capacity within the required limits. When two or more helices or spirals are interlaced, the centre stem being eliminated, the convolutions of the helices or spirals can be insulated one from the other by overwinding with suitable threads. Fig. 4 shows a form of threading the helices, by which a thread of silk, cotton, or the like, takes up a position between the surfaces of the convolutions, thereby forming a suitable spacing. Fig. 3 shows a sectional elevation of one method of utilising the spiral electrodes without a centre stem, the distance between the electrodes and insulation being maintained by the overwound threading as shown in Fig. 4.—*August 30th*, 1939.

AERONAUTICS

512,192. *July 30th*, 1938.—INSPECTION COVER FOR AIRCRAFT WINGS, FLOTATION BODIES, OR OTHER AERODYNAMICAL SURFACES, Short Brothers (Rochester & Bedford), Ltd., and Sidney Gerald Hart, both of Seaplane Works, Rochester.

In applying inspection covers to wings, it is important that such covers should be smooth, free from excrescences and that they should lie flat with the wing surface in order to reduce drag and yet be so constructed as to prevent the ingress of any water, and also be unaffected by vibration. An embodiment of an inspection cover for the upper surface of aircraft wings is shown by way of example. The inspection cover is shaped to correspond approximately in size and form with the hole, and on the inner side of the wing a cover seating member A is attached by a peripheral flange. This cover seating member is bent to provide a part D which projects beyond the borders of the hole and is spaced apart from the wing surface by an amount which is sufficient to receive a rubber sealing member B with its retaining plate and the inspection cover C and also allow of clearance between the inspection cover and the retaining plate. The part D is formed with a circular aperture, the edges of which are flanged inwardly. The rubber sealing member B is shaped to correspond with the inspection cover and is located on the part D. At its centre this sealing member is formed with a circular hole of smaller diameter than the aperture in the cover seating. Owing to this arrangement the sealing member will provide parts which project

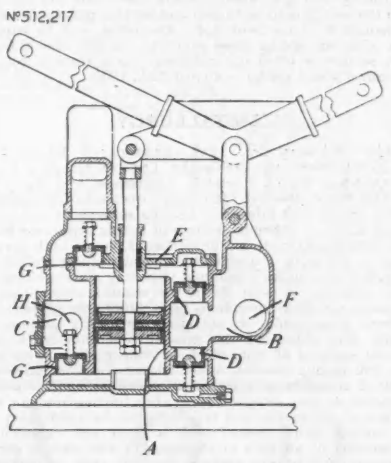


beyond the flanged edges of the cover seating. Fastening devices are mounted in rings E attached to the recessed part of the cover seating at opposite sides of the central aperture. These fastening devices conveniently consist of a well-known form of cowling clip F in which spring pressed jaws (not shown) on the fastening device are adapted to engage with recesses in the ring E and so arranged that the jaws can be readily disengaged. The sealing member and its retaining plate are formed with openings to accommodate the ring E and fastening device. The inspection cover itself consists of the plate C to the underside of which is attached an annulus having its inner border G turned down at right angles to the plate to form an inwardly projecting flange of smaller diameter than the flange on the cover seating, but of larger diameter than the hole in the sealing member. Thus when the inspection cover is placed in position in the hole the inwardly projecting flange G engages with the projecting part of the sealing member and bends it downwardly towards the flange H as shown. The sealing member is made of rubber or other elastic material and thus reacts against the flange on the inspection cover effectively to seal the space between the cover and the cover seating, and also insulate the cover against the effects of vibration. A cord or cable J is attached at one end to the cover seating and at its other end to the cover so as to allow the inspection cover to be moved clear of the aperture but prevent the cover from falling.—*August 30th*, 1939.

PUMPING AND BLOWING MACHINERY

512,217. *December 19th*, 1938.—RECIPROCATORY PUMPS, Lee Howl and Co., Ltd., Tipton Engineering Works, Tipton, Clifford Howl, Ralph Howl, and Walter Russell Sowden, all of the Company's address.

This invention relates to reciprocatory pumps for pumping water or other liquids, and particularly hand pumps, the object of the invention being to simplify and facilitate the manufacture of such pumps. A casting forms an open-ended vertical cylinder



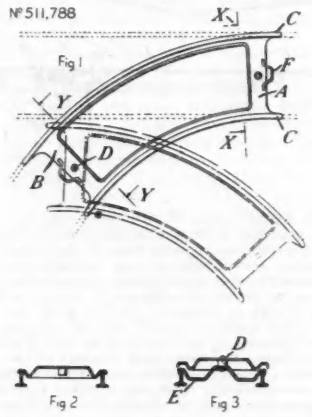
A having combined with it a suction valve chest B and a delivery valve chest C, the valve chests being open at each end and being situated at opposite sides of and parallel with the cylinder. This casting comprises one member of the pump, and is such that the cylinder and locations at the appropriate ends of the valve chests for a pair of suction valve seatings and one of a pair of delivery valve seatings can be bored in one setting. The suction valve seatings D are in the form of bushes which

are mounted at the upper and lower ends of the suction chest, and in combination with the outer end of each is a poppet valve which is held on its seating by a spring supported by the adjacent end cover E. The liquid to be pumped is admitted to the interior of the suction valve chest through an inlet F in an extension of this valve chest, which forms at its upper part a suction air chamber. The delivery valve seatings G also comprise bushes one of which is mounted in the lower end of the delivery chest, and the other of which is mounted in the upper end cover E. In combination with the upper end of each of these seatings is provided a poppet valve which is held on its seating by a spring. The space provided in the upper end cover is also adapted to serve as an air cushion chamber. A delivery outlet H is provided on one or each side of the delivery valve chest at a position between the valves. The upper and lower ends of the cylinder and valve chest casting are closed by the end covers, the lower serving as the base or foot of the pump structure. The piston in the cylinder A is secured to a rod which passes through a gland in one of the end covers, and the outer end of the rod is pivotally attached to a manually-operable actuating lever.—*August 30th*, 1939.

TRAMWAYS AND RAILWAYS

511,788. *February 23rd*, 1938.—Switches for Light Railways and the like, Martin Eichelgrün, 99, Cholmley Gardens, Fortune Green Road, West Hampstead, London, N.W.6, and Erich Schapira, of Kleine Frohngasse 1, Dresden, Germany, trading as Martin Eichelgrün & Co., of Hermann Göring Ufer 82, Frankfurt a.M., Germany.

The invention is an inclined plane switch employing a track section made of a shaped sheet of metal and forming a simple curve, the section being supported near one of its ends on a pivot mounted between the side track rails. If it is desired to switch from the straightaway to the side track or *vice versa* the switch section is rotated laterally away from or toward the main track respectively, similarly to the movement of the tongue of a conventional point switch. The track section is provided with abutments which engage the main track to locate the pivoting section. Provision is made that the rail ridges or rail heads of the switch track section are automatically raised as it is rotated so as not to interfere with the main track rails. Both ends of the switch track section are provided with pivot chairs so that by the employment of one or the other chair the section may serve as a right- and/or left-hand switch, respectively. The drawings illustrate by way of example a switch track embodying the invention. Fig. 1 illustrates a left-hand switch



track section. The full lines show the switch track section in the position wherein traffic is diverted from the main track to a side track, while the dotted lines show its position for continuous movement of traffic on the main track. Fig. 2 is a section along line X—X of Fig. 1 and Fig. 3 is a section along line Y—Y of Fig. 1. The rotatable switch track section comprises a frame, having outer and inner rail heads which are connected by the cross braces A and B. The rail heads are provided at their ends with ramps or climbing tongues C which are adapted to rest on top of the stationary track rails and to permit the wheels of a vehicle to roll on the ramps and thus follow the curve on to the desired track. If the vehicle is to follow the main track the switch track section is turned about the pivot D of a heel chair as shown in dotted lines. As shown in Fig. 3 the heel chair comprises a leaf spring E which is supported on the rail heads of the branch track. The spring supports at its centre a pivot, which is so proportioned that at rest the switch track is supported in a raised position over the stationary rails, in order that the flanges do not interfere with the heads of the stationary rails when the switch is turned. If a vehicle rolls over the pivot end of the switch the tongues of the switch rails are depressed upon the stationary rails so as to rest thereon as shown in Fig. 2 for the other end of the switch track section. By this arrangement the rear end of the switch is normally held in a raised position free of the stationary rails when the switch is to be turned and for this purpose is lifted by the handle F at its front end. The pivot may be supported on a solid, unyielding cross support. In this case the switch track section is lifted automatically upon turning by means of a coiled spiral spring.—*August 24th*, 1939.

METALLURGY

512,125. *February 3rd*, 1939.—Lubricated Bearing Surfaces, Petrie and McNaught, Ltd., St. George's Foundry, Crawford Street, Rochdale, Lancashire, and Harry Shaw, Hill Hurst, Healey, Whitworth, Rochdale, Lancashire.

It is known that lubricated bearing surfaces of iron, steel, or copper alloys of either the sliding or rolling type wear best and have better anti-frictional properties if one or both surfaces is or are in the form of a polished amorphous or so-called Beilby layer, but in practice it is found that only after prolonged rubbing, sufficient to wear down the minute inequalities, is an extensive polished amorphous layer produced. Ferrous metal surfaces in particular do not easily or readily acquire such a finish. The object of the present invention is to provide bearing surfaces of iron, steel, or copper alloys with a layer that will readily assume, under frictional action, an extensive polished amorphous surface, or so-called Beilby layer. It comprises an iron, steel, or copper alloy bearing having a bearing surface of the sherardised type adapted for lubrication in use, the surface being coated with a layer not exceeding one-thousandth of an inch in thickness of zinc and/or cadmium. In preparing a bearing surface, the iron, steel, or copper alloy article to be treated is placed, along with a quantity of metallic zinc dust, in a hermetically sealed container which is revolved slowly and heated to a temperature of from 600 to 800 deg. Fahr., the temperature being maintained for a period of from 1 hour or even less at 800 deg. Fahr. to about 12 hours at 600 deg. Fahr. By varying the quantity of metallic dust, and/or the time and/or the temperature of treatment, the thickness of the coating upon the bearing surface can be varied, an increase in any one or more of the three factors resulting in a thicker deposit, and a decrease in a thinner deposit. As a specific example, the temperature may be 720 deg. Fahr. and the time of treatment 1 hour. Such variations, however, must not, according to this invention, be such as to give a thickness of coating outside the limit above specified.—*August 29th*, 1939.

512,244. *February 26th*, 1938.—Alloy Cast Iron Castings, Sheepbridge Stokes Centrifugal Castings Company, Ltd., Sheepbridge Works, Chesterfield, and Alexander John Stokes, Sheepbridge Works, Chesterfield.

According to the invention, a process for the production of a machined casting composed of alloy cast iron, more especially a cylinder liner, piston ring, or valve seat insert of an internal combustion engine, consists in casting the object from a melt containing, in addition to iron, approximately equal percentages of carbon and silicon. These percentages range from 1·8 to 2·5 per cent., a small percentage of aluminium not exceeding 1 per cent., and a proportion of chromium ranging from 15·5 to 20·5 per cent., with or without a small percentage or percentages of manganese and/or phosphorus not exceeding, in the case of manganese, 1·5 per cent. and, in the case of phosphorus, 1 per cent. (the various percentages stated being by weight and as reckoned upon the total weight of the alloy). The casting is allowed to cool to a temperature at or near atmospheric temperature, and then heated to 950–990 deg. Cent. for a period of time sufficient to render it, upon re-cooling down to atmospheric temperature, machinable. It is then machined and re-hardened by first heating for a short time, for example 1 hour, to 950–970 deg. Cent. and then quickly cooling. The re-hardened casting is then tempered by heating it to 570–700 deg. Cent. More specifically, the composition of the melt from which the casting is produced may be as follows :—

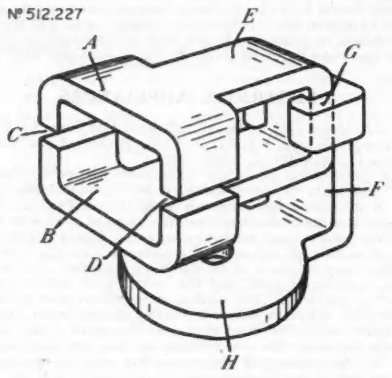
Carbon	1·8 to 2·5 per cent.
Silicon	1·8 to 2·5 per cent.
Aluminium	0·01 to 1·0 per cent.
Chromium	15·5 to 20·5 per cent.
Manganese	0·35 to 1·5 per cent.
Phosphorus	0·01 to 1·0 per cent.
Iron...	remainder

Sulphur may be present as an impurity in proportions up to about 0·12 per cent., and small amounts of the following alloying elements, molybdenum, nickel, zirconium, copper, tungsten, titanium, and vanadium, may also be present, in which event the individual elements should not be present in amount exceeding 1·0 per cent., or if two or more are added, in a total amount exceeding 3·0 per cent. It is essential that the amounts of carbon and silicon present in the alloy shall be substantially equal to one another within practical limits of production.—*August 31st*, 1939.

MISCELLANEOUS

512,227. *January 13th*, 1939.—Permanent Brake Magnets of High Coercive Force, Landis and Gyr A.—G., of Hofstrasse 1, Zug, Switzerland.

According to this invention, in a brake magnet arrangement, a permanent brake magnet, consisting of a single unitary structure of a material of high coercive force with two limbs having two air gaps between them and being united by a yoke extending from the neutral zone of the magnet limbs, has connected to the yoke thereof a strap or angle piece to permit the magnet to be secured in position and adjusted as required. The accompanying drawing shows by way of example, diagrammatically and in perspective, one embodiment of the invention. Two magnet limbs A and B are turned at their ends towards each other leaving between them two air gaps C and D. From the neutral zones of these limbs A and B, that is, where no magnetic effect is observable in the magnetic system, there



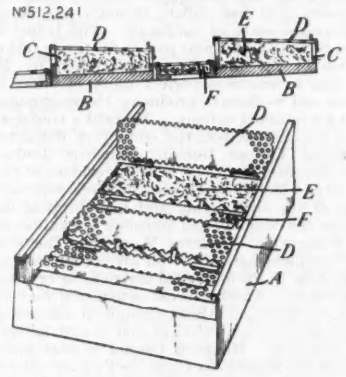
extends a yoke E. This yoke forms a single or unitary structure with the limbs A, B, that is, the limbs A, B are united into a single piece by the yoke so that the size of the air gaps remains fixed. The unit forming the magnet is made, for example of cobalt steel, and can be cast in a mould or can be formed, *e.g.* stamped out of drawn band, and then bent. As the fastening of the magnet in an apparatus, there is employed as shown, a strap or loop F which by means of arms G embraces the yoke E at its central part, and which has a disc-shaped part H by means of which the whole holding device can be fixed in any usual manner in, for example, an electricity meter. Owing to the magnet according to the invention being formed with two air gaps and consisting of a single piece of material, there is attained a high braking force with the exclusion of the danger of a variation of the air gaps and with the possibility of using a simple holding device presenting no particular demands in the space taken up thereby.—*August 30th*, 1939.

512,252. *March 4th*, 1938.—Selenium Rectifiers, *Standard Telephones and Cables, Ltd., Connaught House*, 63, *Aldwych, London, W.C.2.*

According to this invention a process of manufacturing a selenium rectifier or photo-electric cell comprises coating a base plate composed of a metal of the iron group with selenium at a temperature in excess of 270 deg. Cent. and rapidly cooling the coated base plate to a temperature below 70 deg. Cent. A base plate composed of a metal of the iron group must be taken to include a base plate of any metal coated with a metal of the iron group, the selenium being applied to the coating of the metal of the iron group. The most convenient manner of carrying out the invention is as follows :—Plates of a metal of the iron group which are to form base plates are thoroughly cleaned and then arranged in a row in an electric furnace, the interior of which is kept at 270 deg. Cent. or higher by any suitable method. After the base plates have remained in the furnace for a time sufficient to have been at the temperature of the furnace for several minutes, selenium, which has been separately melted, is coated uniformly upon the base plates with a suitable tool. The base plates are then removed from the furnace and allowed to cool rapidly to room temperature which is below 70 deg. Cent. The selenium is thus caused to adhere strongly to the base plate and no subsequent separation occurs during a succeeding heat treatment. Selenium even adheres to the base plate if struck strongly with a hammer. The further processes of heat treatment of the selenium and attachment of a further electrode to the selenium are carried out in any well-known or suitable manner. Selenium rectifiers manufactured in the above mentioned way show small resistance in the forward direction of the rectifier and also very steady electrical characteristics. The forward resistance is about 20 ohms per square cm. and at a voltage of 2 volts the rectification ratio is above 5000 on the average.—*August 31st*, 1939.

512,241. *February 25th*, 1938.—Magnetic Separators, Herbert Huband Thompson, Alfred Evan Davies, and Millward Dudley Thompson, of Magnet Works, Lombard Street, Birmingham, 12.

This invention relates to magnetic separators for the removal of magnetic particles from liquid or semi-liquid materials such as potters' slip, glazes, paper pulp, gun-cotton pulp, and other materials of similar consistency, or for the separation of materials in suspension in a liquid. One form of magnetic separating means is illustrated in the accompanying drawings. The separating elements shown are adapted for use with a separator of known type in which the material to be treated flows down an inclined trough A across the bottom of which are arranged spaced transverse steel or iron bars B of substantial width forming the pole-pieces of electro-magnets arranged below the trough, the bars being alternately of opposite polarity. Each bar forms the base of a skeleton metal box or frame C having a perforated cover D. The upper and lower sides of the box, that is the sides directed towards and away from the flow of material, are also perforated, and the cover is hinged to the lower side and retained by catches on the upper side. The box is filled with a foraminous filling E consisting of a mass of interwoven flat



steel or iron wire. This filling is magnetised by the bar and presents a very large surface area as well as a very great length of sharp edge having a high magnetic intensity. A shallower skeleton box F having a perforated top is arranged transversely in the trough between adjacent boxes and this is also filled with the same foraminous material. The lower side of each box is made higher than the upper so that the covers are substantially horizontal and the bottom part of each lower side is not perforated. Thus as the material to be treated flows down through each box, it must on entering each accumulate until it reaches a level sufficient to pass out of the perforations in the lower side. It then flows over into the box F and when that is full it flows into the next box and so on. Thus the material as it passes through each box or frame is brought into intimate contact with the filling and is thoroughly searched so that all magnetic particles in the material are retained by the filling. To remove the magnetic particles when the machine is stopped the boxes or frames can simply be lifted out and washed in running water.—*August 31st*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Engineers and Shipbuilders in Scotland

Tuesday, November 21st.—39, Elmbank Crescent, Glasgow. "Characteristics of Silent Propellers," A. W. Davis. 6.30 p.m.

Institution of Structural Engineers

Saturday, October 28th.—Yorkshire Branch. Council Chamber, Town Hall, Brighouse, Near Huddersfield. Chairman's Address, H. A. Sneezum. 2.30 p.m.

Iron and Steel Institute

Thursday, Nov. 23rd.—4, Grosvenor Gardens, S.W.1. Statutory Autumn Meeting. 3.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, Oct. 27th.—Mining Institute, Newcastle-upon-Tyne. "Rolling of Ships under Way : The Decrement of Roll due to Hull and Bilge Keels," G. S. Baker. 5.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

The British Rubber Publicity Association informs us that it has opened a branch office at 1, Albert Mansions, Lansdowne Road, Croydon, Surrey, to which address all communications should be sent.

John I. Thornycroft and Co., Ltd., announce that Mr. R. F. Newman has been appointed general manager of their Basingstoke Works. Mr. Newman has been in the service of the company for a number of years, both in the branches abroad as well as at home, and for the last few years has been assistant general manager at Basingstoke.

CATALOGUES

British Thomson-Houston Co., Ltd., Crown House, Aldwych, W.C.2.—New "Mazda" lamp catalogue.

Metropolitan-Vickers Electrical Co., Ltd., 1, Kingsway, London, W.C.2.—Catalogue of "Metrovick" and "Cosmos" lamps.

B. and S. Massey, Ltd., Openshaw, Manchester, 11.—Leaflet 4400H, giving details of the various types of trimming presses made by the firm.

Murex Welding Processes, Ltd., Hertford Road, Waltham Cross, Herts.—Brochure on the hard surfacing of steel by the electric arc welding process.